

A review of the gymnosperms of the Northern Territory

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ABSTRACT

A treatment of the ‘gymnosperms’ native to the Northern Territory is provided. Fourteen species are recognised in four genera: *Podocarpus* (one species), *Callitris* (two species), *Cycas* (10 species), and *Macrozamia* (one species). *Cycas brunnea* is not recognised as occurring in the Northern Territory. The subspecies of *Cycas arnhemica* are reduced to synonymy under this species and *Cycas canalis* subsp. *carinata* is reduced to synonymy under *Cycas canalis*. Only two subspecies, *Cycas maconochiei* subsp. *maconochiei* and *Cycas maconochiei* subsp. *viridis*, are recognised for *Cycas maconochiei*. Identification keys to the genera, species, and infraspecific taxa in the Northern Territory are provided. Descriptions, notes, illustrations and distribution maps are also provided.

KEYWORDS: gymnosperm, Cycadophyta, Pinophyta, *Callitris*, *Podocarpus*, pine, *Cycas*, *Macrozamia*, cycad, zamia, Northern Territory, Australia.

INTRODUCTION

It is 87 years since the only complete treatment of the Flora of the Northern Territory was published by Ewart and Davies (1917). Although this Flora has been criticised (Anon in Chippendale 1971; Short 1997), there is no doubt that it was an accomplishment for its time, as even today there is no intention to produce a Territory-wide flora. However, with the preparation of treatments for the non-angiosperm families for the long anticipated first volume of the Flora of the Darwin Region, it was realised that with little extra effort a treatment of the ‘gymnosperms’ covering all of the Northern Territory could be accomplished. The task was made easier by a recent treatment of the ‘Gymnosperms’ in volume 48 of the Flora of Australia (Hill 1998a, 1998b).

Ewart and Davies (1917) recorded and described three ‘gymnosperms’ for the Northern Territory. Data obtained from the Flora of Australia (1998, Vol 48) indicated that 15 ‘gymnosperm’ species are recognised as occurring in the Northern Territory. Forestry plantations of *Pinus caribaea* Morclet and *Pinus oocarpa* Schiede have been established on the Tiwi Islands, but have not become naturalised (Ian Cowie, pers. comm.). Recent field work in some of the more remote and inaccessible areas by the author and other collectors has revealed range extensions and additional data for some species. These additional data include a southern range extension for *Cycas pruinosa* (Kirkimbie Station), an eastern (Gimbat Homestead) and northern (Burrell Creek near Adelaide River township) range extension for *Cycas conferta*,

rediscovery of *Cycas armstrongii* from the type locality on Cobourg Peninsula (Port Essington), and a southern range extension for *Cycas canalis* (Flora River Conservation Reserve).

MATERIALS AND METHODS

Herbaria abbreviations follow Holmgren *et al.* (1990). Abbreviations for the Northern Territory and for Australian states appear as N.T., Qld, W.A., S.A. and N.S.W. under the sections on types, specimens examined and distribution for each species, whereas they are written in full elsewhere.

All species descriptions and illustrations have been prepared solely from Northern Territory specimens held at the Northern Territory Herbarium (DNA), and National Herbarium of New South Wales (NSW). Specimens of *Cycas maconochiei* subsp. *viridis* K.D. Hill were received on loan from New South Wales.

With the exception of *Cycas arenicola* K.D. Hill and *Cycas maconochiei* subsp. *viridis*, all Northern Territory *Cycas* were examined in habitat. Provenanced living collections of *Podocarpus grayae* de Laub., and *Macrozamia macdonnellii* (F. Muell. ex Miq.) A. DC. were examined at the George Brown Darwin Botanic Gardens. *Callitris glaucophylla* J. Thompson and L.A.S. Johnson was not examined in habitat. The family concepts used in this paper, although not described, are those used in the *Flora of Australia*, Vol. 48 (1998). All illustrations were drawn by Monika Osterkamp-Madsen. Collections cited in the specimen examined sections are sorted alphabetically by collector.

SYSTEMATICS

Key to the 'gymnosperm' families and genera in the Northern Territory

- 1a. Palm-like plants with pinnate leaves..... 2
 1b. Trees with or without obvious leaves..... 3
 2a. Pinnae with prominent midvein.....
Cycadaceae, *Cycas*
 2b. Pinnae with parallel venation
Zamiaceae, *Macrozamia macdonnellii*
 3a. Adult leaves scale-like
Cupressaceae, *Callitris*
 3b. Adult leaves flattened with an obvious midrib ..
Podocarpaceae, *Podocarpus grayae*

Podocarpaceae

A family of 180 species representing 18 genera. Found throughout Africa, Japan, Malesia, Australia, New Zealand and South America. Sixteen species in Australia, one species in the Northern Territory. Taxonomic references: de Laubenfels (1985); Hill (1998a).

Podocarpus L'Hér. ex Pers.

Dioecious, rarely monoecious, trees or shrubs. Leaves linear, oblong, spirally arranged, pseudo-whorled, with a distinct midrib. Male strobili cylindrical, sessile or stalked, solitary or axillary in groups of the upper leaves; microsporophylls crowded, spirally arranged. Female cone a single fertile scale bearing 1 or 2 (–3) ovules. Fertile scales fused to 1 or more sterile scales; fused structure (receptacle) solitary on a short axillary shoot or peduncle, fleshy or leathery and becoming strongly coloured at maturity. Peduncle naked. Seed coat leathery at maturity, red, purple or black.

A genus of 94 species, widely distributed through the Americas, Africa, Australia, New Zealand, the Pacific islands, and Asia. Seven species in Australia, one in the Northern Territory.

Podocarpus grayae de Laub.

(Figs 1, 2A–B)

Brown Pine

Podocarpus grayae de Laub., *Blumea* 30: 275 (1985) as '*grayii*'.

Type: upper Parrot Creek, Annan River, Cape York, Qld, 12 September 1948, *L.J. Brass 20203*; holo: L (photo seen); iso: A n.v., BRI n.v., K n.v.

Specimens examined. (selection only, 12 collections seen). Australia, Northern Territory: Podocarpus Gorge, 1 March 1990, *Brennan, K.G. 259* (DNA); tributary of East Alligator River, 20 June 1996, *Liddle, D.T. 1565 and Dempster, R.* (BRI, CANB, DNA, MEL); upper Goomadeer River, 29 October 1987, *Russell-Smith, J. 3858 and Lucas, D.* (CANB, DNA, NSW); upper East Alligator River, Arnhem Land, 20 April 1988, *Russell-*

Smith, J. 5254 and Lucas, D. (BRI, DNA); 53 km E of Jabiru, Arnhem Land, 25 October 1987, *Russell-Smith, J. 3761 and Lucas, D.* (BRI, CANB, DNA, K, MEL, NSW).

Description. Tree to 12 m. Bark thin, smooth to thinly scaly. Leaves with petiole 4–8 mm long; lamina linear, 6–25 cm long, 9–17 mm wide, dark green; midrib depressed on upper surface, prominently raised on lower surface, apex acuminate, base cuneate. Male cones cylindrical 20–30 mm long, 3–4 mm diameter, sessile or on peduncles to 1 mm long, in groups of 1–4; microsporophylls loosely imbricate triangular to 2 mm long, short. Female cones of 1 fertile scale with one or two ovules. Solitary, axillary on peduncles 6–9 mm long; receptacle 9–14 mm long, fleshy, red at maturity. Mature seed to 15 mm long, to 12 mm diameter, dark red. **Fertile plants:** April and October.

Distribution. In the Northern Territory, *P. grayae* is restricted to the western Arnhem Land escarpment (Fig. 1). Also found in north-east Queensland.

Notes. *Podocarpus grayae* occurs in monsoon vine forest on sandstone, frequently with *Allosyncarpia ternata*. As DNA holds very few specimens of *P. grayae*, the description presented above has been modified from Hill (1998a).

Various spellings of the specific epithet have been used for this taxon. On the holotype, de Laubenfels has annotated the specimen '*Podocarpus grayi*'. In his revision of *Podocarpus*, de Laubenfels (1985) used the epithet '*grayii*'. As *P. grayae* was clearly named after Netta Gray (see de Laubenfels 1985: protologue) the ending requires correction. According to Article 60 of the International Code of Botanical Nomenclature (ICBN) (Greuter *et al.* 2000), 'the original spelling of

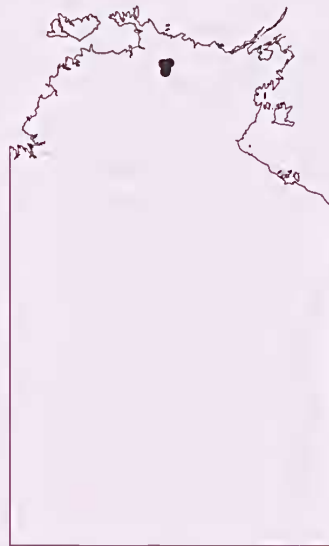


Fig. 1. Distribution of *Podocarpus grayae* in the Northern Territory.

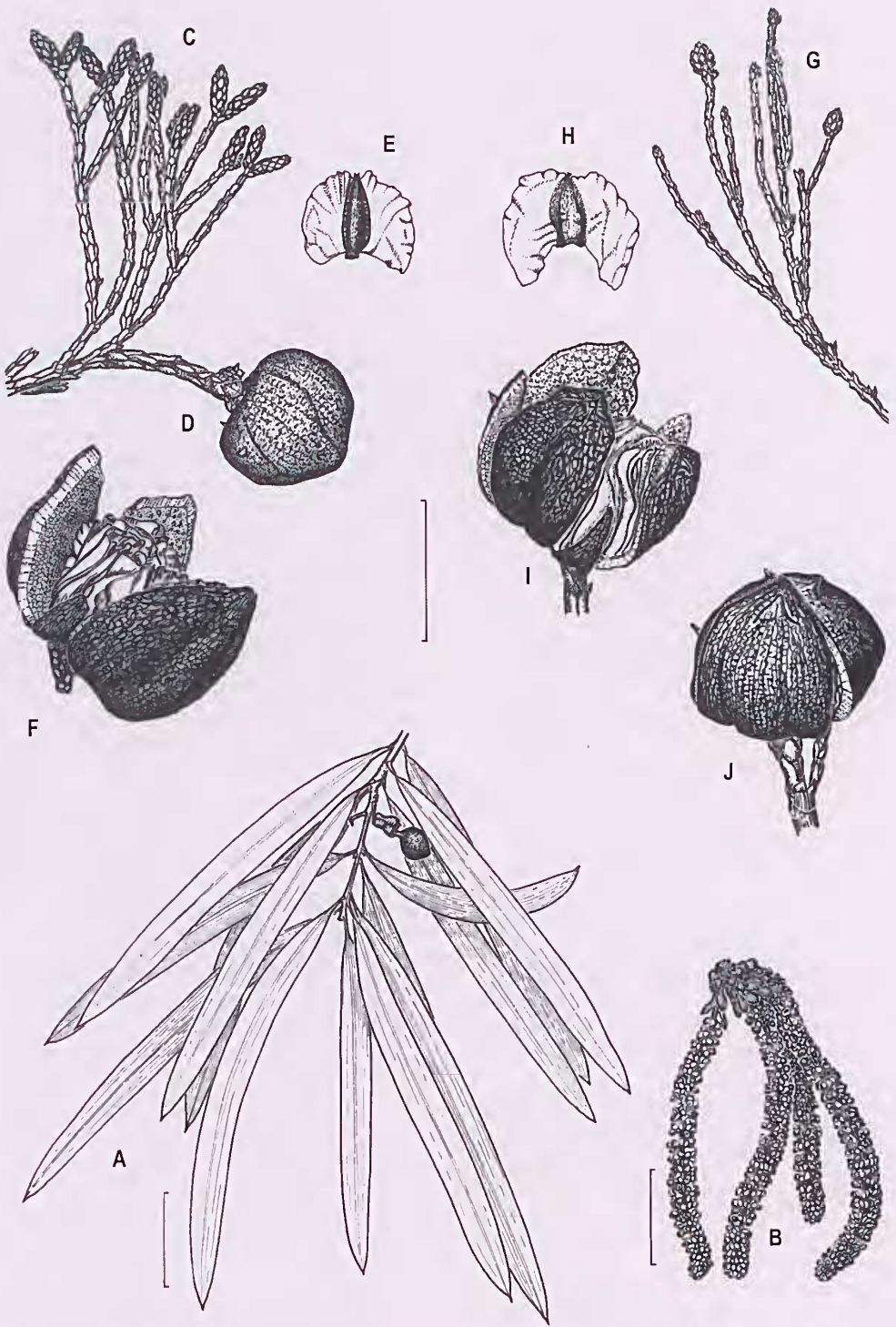


Fig. 2. A, B. *Podocarpus grayae*: A, tip of branch with female strobilus (Brennan 1390); B, male strobili (Bowman s.n. DNA51738). C-F. *Callitris glaucophylla*: C, tip of branch with male strobili; D, female cone, E, seed, and F, open cone (Barritt 1141). G-J. *Callitris intratropica*. G, tip of branch with male strobili (Smith 334); H, seed; I, open female cone, and J, closed female cone (Henry 74). Scale bars: A = 3 cm, B-J = 1 cm.

a name or epithet is to be retained, except for the correction of typographical or orthographical errors...'. Recommendation 60C of the ICBN provides examples of masculine and feminine endings for Latinised personal names and as such the ending of the specific epithet as been corrected accordingly to reflect its feminine origin.

Cupressaceae

A cosmopolitan family of 155 species representing 30 genera. Twenty-two species in Australia. One genus with two species in the Northern Territory. Taxonomic reference: Hill (1998a).

Callitris Vent.

Monoecious trees or shrubs. Juvenile leaves acicular in whorls of 4. Adult leaves much reduced, appressed, triangular, alternating in whorls of 3. Male cones terminal, solitary, paired or clustered; scales imbricate trimerous, whorled; microsporangia 2–6, abaxial. Female cones solitary or clustered, scales in 2 whorls of 3; fertile scales with 1–8 ovules. Mature cones persistent or deciduous. Seeds 1–8 per scale, 1–3 winged.

A genus of 19 species, 17 of which are found in Australia, two in the Northern Territory.

Key to the species of *Callitris* in the Northern Territory

- 1a. Foliage grey-green or glaucous .. *C. glaucophylla*
1b. Foliage dark green *C. intratropica*

Callitris glaucophylla J. Thompson and L.A.S. Johnson

(Figs 2C–F, 3)

White Cypress or White Pine

Callitris glaucophylla J. Thompson and L.A.S. Johnson, *Telopea* 2: 731 (1986).

Type: Noonah Vale, c. 28 km SW of Garah, N.S.W., 29°08'S, 140°26'E, 5 October 1978, *K.L. Wilson 1942*; holotype: NSW, *n.v.*; iso: BRI, *n.v.*, K, *n.v.*, RSA, *n.v.*

Callitris columellaris var. *campestris* Silba, *Phytologia Mem.* 7: 16 (1984). **Type:** cited as Grangie, N Boulalilen [Trangie, *W. Baeuerlen*], N.S.W., November 1902; holotype: *n.v.*

Specimens examined. (selection only, 49 collections seen). Australia, Northern Territory: 3.5 km SE Mt Freeling, 3 March 1998, *Albrecht, D.E. 8469 and Gaskon, W.* (NT); 9 km NW Inindia Bore, Curtin Springs Station, 25 March 1998, *Albrecht, D.E. 8555* (NT); Upper Stokes Creek, Watarrka National Park, 24 August 2002, *Barnetson, J.S. 130* (NT); Rainbow Valley Conservation Reserve, 300 m SW of outcrop, 29 July 1992, *Barritt, M.J.A. 1141* (AD, DNA, MEL, NT); 20 miles W Ormiston Gorge Waterhole, W Macdonnell Range, 20 January 2003, *Bell, C.L. 10* (NT); 4 km E of first rest area, Namatjira Drive, 17 October 2001, *Collins, T.L. 13* (NT); Napperby, 24 January 1950, *Everist, S.L.*

4189 (DNA); Joker Gorge, 4 February 1994, *Fischer, G. s.n.* (NT); Paddy's Gorge, 4 February 1994, *Fischer, G. s.n.* (NT); N'Dhala Gorge Nature Park, 21 August 1999, *Gray, B. 18* (NT); S of Lake Neale, 12 April 1972, *Henry, N.M. 430* (DNA, NT); 14 km E Atnarpa Homestead, 18 July 1991, *Latz, P.K. 12081* (NT); Mt Mary, E Harts Range, 28 October 1993, *Latz, P.K. 13465* (DNA, MEL); W end of Mt Riddock, 25 October 1993, *Latz, P.K. 13433* (DNA, MEL); 16 km NNW Wallara Ranch, 20 September 1998, *Latz, P.K. 15653* (NT); Ilparpa Range, S of Alice Springs, 1 January 1991, *Latz, P.K. s.n.* (NT); Ooramina, 28 April 1975, *Latz, P.K. s.n.* (NT); Kernot Range, Angus Downs Station, 13 September 1999, *Latz, P.K. 15966* (NT); 20 km ESE Ellery Big Hole, 19 May 2000, *Latz, P.K. 16186* (NT); 43 km SW Haasts Bluff Settlement, 25 November 2000, *Latz, P.K. 17399* (NT); Finke Gorge N.P., N of campground, 9 March 1995, *McDonald, S. s.n.* (NT); Palm Valley, 13 October 1996, *Michell, C.R. 421 and McGregor, F.* (DNA, NY); 34 miles NW Glen Helen Homestead, 5 February 1955, *Winkworth, R.E. 840* (CANB, DNA); 8 miles W Mt Doreen Station, 5 July 1954, *Winkworth, R.E. 441* (CANB, DNA).

Description. Tree to 15 m. Leaves 1–3 mm long on ultimate branchlets, grey-green often glaucous. Male cones solitary, cylindrical, to 6 mm long. Female cones solitary, ovoid to depressed-globular, 15–20 mm diameter; 3 large cone scales alternating with 3 small cone scales, separating almost to the base and spreading widely after opening. Seeds numerous with wings to 4 mm wide. **Fertile plants:** all year.

Distribution. In the N.T., restricted to S of latitude 22° (Fig. 3). Also in Qld, N.S.W., S.A. and W.A.

Notes. Grows predominantly on rocky slopes and in gorges on a variety of substrates such as sandstone, quartzite, granite, and dolomite.

Callitris intratropica R.T. Baker and H.G. Sm.

(Figs 2G–J, 3)

Callitris intratropica R.T. Baker and H.G. Sm., *Res Pines Australia* 172 (1910).

Callitris columellaris var. *intratropica* (R.T. Baker and H.G. Sm.) Silba, *Phytologia Mem.* 7: 16 (1984); *Frenela robusta* var. *microcarpa* A. Cunn. ex Benth., *Fl. Austral.* 6: 237 (1873); *Callitris robusta* var. *microcarpa* (A. Cunn. ex Benth.) F.M. Bailey, *Sydney Queensland Fl.* 497 (1883); *Callitris robusta* var. *intratropica* (R.T. Baker and H.G. Sm.) Ewart and O. Davies, *Fl. N. Terr.* 19 (1917).

Type: Arnhem Land, N.T., *F. Mueller*; lecto: K, *n.v.*; isolecto: K *n.v.*

Specimens examined. (selection only, 67 collections seen). Australia, Northern Territory: tributary of Allia Ck, c.9 km S of Fletcher Gully Mine, 9 May 1994, *Albrecht, D.E. 5970 and Cowie, I.D.* (DNA, NT); SE of Brocks Creek, 5 July 1946, *Blake, S.T. 16342* (BRI,

DNA); 2 km S of Magela Falls, 22 May 1994, *Brennan, K.G. 2843* (DNA); English Company Islands, Inglis, 19 September 1996, *Brennan, K.G. 3358* (DNA); Wadeye, 30 July 1993, *Coleman, C. 580* (DNA); Seven Emu Station, 30 May 1993, *Conn, B.J. 3769 and Donst, A.N.L.* (DNA, NSW, MEL); Groote Eylandt, near Emerald River, 12 September 1991, *Cowie, I.D. 2033 and Brocklehurst, P.* (CANB, DNA, MEL); Melville Island, Pickertaramoor, 31 March 1994, *Cowie, I.D. 4833* (DNA); Litchfield National Park, track to Lost City, 24 March 1995, *Cowie, I.D. 5385 and Taylor, S.M.* (DNA); South West Island, Sir Edward Pellew Group, 9 February 1976, *Craven, L.A. 3736* (CANB, DNA); Macadam Range, 2 March 1989, *Dunlop, C.R. 8088 and Leach, G.J.* (DNA, MEL); Donydji, Arnhem Land, 15 June 1989, *Dunlop, C.R. 8459 and White, N.G.* (DNA); Cape Shield, 4 May 1993, *Dunlop, C.R. 9468 and Cowie, I.D.* (DNA); Angalarri River catchment, 15 May 1994, *Dunlop, C.R. 10046 and Latz, P.K.* (DNA, MEL); Moyle River, 70 km E of Port Keats, 10 May 1994, *Dunlop, C.R. 13778 and Latz, P.K.* (DNA, MEL); Winchelsea Island, 14 May 1993, *Egan, J.L. 2463* (DNA); Nitmiluk National Park, "Tasmania", near Mt Shepherd, 7 November 1990, *Evans, M. 3461* (DNA, K); 56.5 km E of Beswick, 23 August 1991, *Hill, K.D. 3898 and Stanberg, L.* (CANB, DNA, NSW); Fitzmaurice River headwaters, 13 May 1994, *Latz, P.K. 13891 and Dunlop, C.R.* (CANB, DNA); Bickerton Island, Milyakburra Community, 29 April 1993, *Leach, G.J. 3473 and Dunlop, C.R.* (DNA); Elcho Island, 2 July 1975, *Maconochie, J.R. 2101* (CANB, DNA, K); Vicinity of El Sharana Mining Camp, 17 January 1973, *Martensz, P. AE366 and Schodde, R.* (BRI, CANB, DNA); 34 miles

NE Goyder River Crossing, 17 June 1972, *Must, J. 1022* (CANB, DNA, K); Berry Spings, 13 December 1974, *Parker, M.O. 602* (DNA, MO); 10 miles N of Borroloola, 27 July 1948, *Perry, R.A. 1780* (CANB; DNA); near Jabiluka, W Rock Pools Geringbah Escarpment Base, 24 July 1980, *Puttock, C.F. 10169 and Waterhouse, J.T.* (CANB, DNA, NSW, QRS); Mt Borraile, near Tassie Tiger site, Arnhem Land, 31 August 2002, *Rochford, D.C. 73 and Pritchard, M.A.* (DNA); 10 km S Maningrida, 22 June 1987, *Smith, N.M. 662* (DNA); Elcho Island, 1 km E barge landing, 28 April 1987, *Smith, N.M. 582* (DNA); White Stone near Barunga Community, 11 December 1996, *Smith, N.M. 3940* (DNA); 20 miles NE of Dorisvale Station, 14 August 1961, *Speck, N.H. 1601* (CANB, DNA); 37 km E of Goyder River Crossing, 17 June 1972, *Synon, D.E. 7744* (AD, DNA); Vanderlin Island, 10 km S Lake Eames, 26 July 1988, *Thomson, B.G. 2631* (DNA); Yambarran Range, 19 km NE Mt Milik Monmir, 15 May 1994, *Walsh, N.G. 3785 and Leach, G.J.* (DNA, MEL); Murgarella, Brady's Road, 9 July 1985, *Wightman, G.M. 1934* (DNA); 15 km N Nathan River Station Homestead, 8 May 1985, *Wightman, G.M. 1874* (DNA); Cobourg, Buffalo River, 15 August 1995, *Wightman, G.M. 6480* (DNA); 30 km W of Katherine, 19 July 1995, *Wightman, G.M. 6456 and Jackson, D.M.* (DNA); Spirit Hills Station, Site 1, 20 August 1987, *Wilson, P.L. 779* (DNA).

Description. Tree to 24 m. Leaves ca. 2 mm long on ultimate branchlets, dark green. Male cones solitary or in small clusters at tips of branchlets, elongate-ovoid, to 3 mm long. Female cones solitary, usually depressed-globular, 12–18 mm diameter; 3 large cone scales alternating with 3 small cone scales, separating almost to the base and spreading widely after opening. Seeds numerous with wings to 4 mm wide. Fertile plants: all year.

Distribution. Occurs N of latitude 17° in the N.T. (Fig. 3). Also in W.A. and Qld.

Notes. Occurs on sandy soils in open woodland, and on rocky outcrops of laterite, sandstone, and quartzite. Used in timber plantations in the Howard Springs area.

Cycadaceae

A monogeneric family with species found in east Africa, Madagascar, Malcsia, Asia, S.E. Asia, Polynesia and Australia. Taxonomic references: Hill (1992, 1993, 1994, 1996, 1998b). Other useful references: Hill and Osborne (2001), Jones (2002), and Whitelock (2002).

Cycas L.

Palm-like plants with erect, cylindrical stems with persistent leaf bases, occasionally branched, or subterranean trunks (not in Australia), dioecious. Leaves pinnate, spirally arranged, evergreen or deciduous, alternating with flushes of cataphylls. Pinnae entire or divided (not in Australia), with a single midrib, lateral veins absent. Male sporophylls produced on determinate

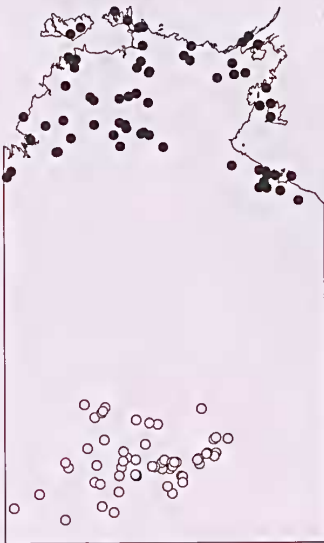


Fig. 3. Distribution of *Callitris* in the Northern Territory. *Callitris glaucophylla* (open circles), *Callitris intratropica* (closed circles).

cones with a central axis, lamina terminating with an upturned spine. Female sporophylls spirally arranged around the apical meristem. Ovules 1–12, inserted opposite or alternately on the lamina. Female sporophyll apex flattened, margin entire or toothed, and terminating with a spine. Seeds yellow, orange or brown.

A genus of ca. 50 species, ca. 27 species are found in Australia, with 10 found in the Northern Territory. In Australia restricted to the tropical areas of Western Australia, the Northern Territory and Queensland. Two exotic species, *Cycas revoluta* Thunb. and *Cycas thouarsii* R. Br. ex Gaudieh., are common cultivated species in Darwin.

Key to the species of *Cycas* in the Northern Territory

- 1a. Pollen cones fusiform; margins of pinnae revolute, or recurved and tomentose, or pubescent below 2
- 1b. Pollen cones ovoid-globose; margins of pinnae flat, or recurved and glabrous, or pubescent below 4
- 2a. Leaves deeply keeled in cross section at least in distal 2/3 of frond; pinnae of mature fronds glabrous, or sparsely pubescent below *C. pruinosa*
- 2b. Leaves flat in cross section; pinnae of mature fronds tomentose below 3
- 3a. Ultimate basal pinnae spaced at 8–14 mm along rachis; median pinnae to rachis angle 46°–58°; bases of median pinnae decurrent for 2.0–4.5 mm along rachis; margins of pinnae recurved *C. arenicola*
- 3b. Ultimate basal pinnae spaced at 2–7 mm along rachis; median pinnae to rachis angle 60°–74°; bases of median pinnae decurrent for 0.5–1.5 mm along rachis; margins of pinnae revolute *C. calcicola*
- 4a. Leaves deeply keeled in cross section; large robust trees up to 12 m tall *C. angulata*
- 4b. Leaves flat or shallowly keeled in cross section; trees up to 6 m 5
- 5a. Midvein of pinnae very prominently raised on abaxial surface when compared with adaxial surface 6
- 5b. Midvein of pinnae not very prominently raised on abaxial surface when compared with adaxial surface 8
- 6a. Cataphyll tips pungent; abaxial surface of pinnae glabrous or almost so *C. orientis*
- 6b. Cataphyll tips not pungent; abaxial surface of pinnae brown pubescent 7
- 7a. Cataphylls densely brown woolly; seed pruinose; west coast of Top End *C. maconochiei*
- 7b. Cataphylls densely orange-grey tomentose; seed not pruinose; central Arnhem Land *C. arnhemica*

- 8a. Median pinnae overlapping or spaced at up to 2.4 mm along the rachis; basal pinnae spaced at 0.4–6.6 mm along rachis *C. conferta*
- 8b. Median pinnae never overlapping and spaced from 3.0–7.4 mm along rachis; ultimate basal pinnae spaced at 7.5–19.7 mm along rachis 9
- 9a. Pinnae dull glaucous, some evidence of wax on petiole; cataphylls densely dark-orange woolly; seed glaucous/pruinose *C. canalis*
- 9b. Pinnae shiny, not glaucous; cataphylls light orange tomentose, glabrescent; seed not glaucous/pruinose *C. arnstrongii*

***Cycas angulata* R. Br.**
(Figs 4, 5A–H)

Cycas angulata R. Br. *Prodr.* 348 (1810).

Type: Bountiful Island, Qld, R. Brown; holotype: ?BM; iso: ?K.

Specimens examined. (selection only, 46 collections examined). Australia, Northern Territory: McArthur River Area, 6 June 1976, Craven, L.A. 4155 (CANB, DNA); Little Wearyan River, 21 November 2002, Dixon, D.J. 1064 and Pritchard, M.A. (DNA); Manangoora Homestead, 26 September 1991, Hill, K.D. 4132 and Stanberg, L. (CANB, DNA, NSW); Wollgorang Station, upper Settlement Creek, 27 September 1991, Hill, K.D. 4135 and Stanberg, L. (CANB, DNA, NSW); 2 km E of Foelsehe River, 16 June 1992, Larcombe, D.R. 68 (DNA); Upper Debbil Creek, spring, 25 January 1989, Latz, P.K. 11247 (DNA, MEL, MO); Wearyan River crossing, 58 km E McArthur River crossing, 17 June 1974, Maconochie, J.R. 2046 (DNA); Along Foelsehe River, Borroloola area, 17 September 1994, Robertson, R.M. 10 (DNA); Echo Gorge, along Wollgorang road 30 km SW Wollgorang, 16



Fig. 4. Distribution of *Cycas angulata* in the Northern Territory.

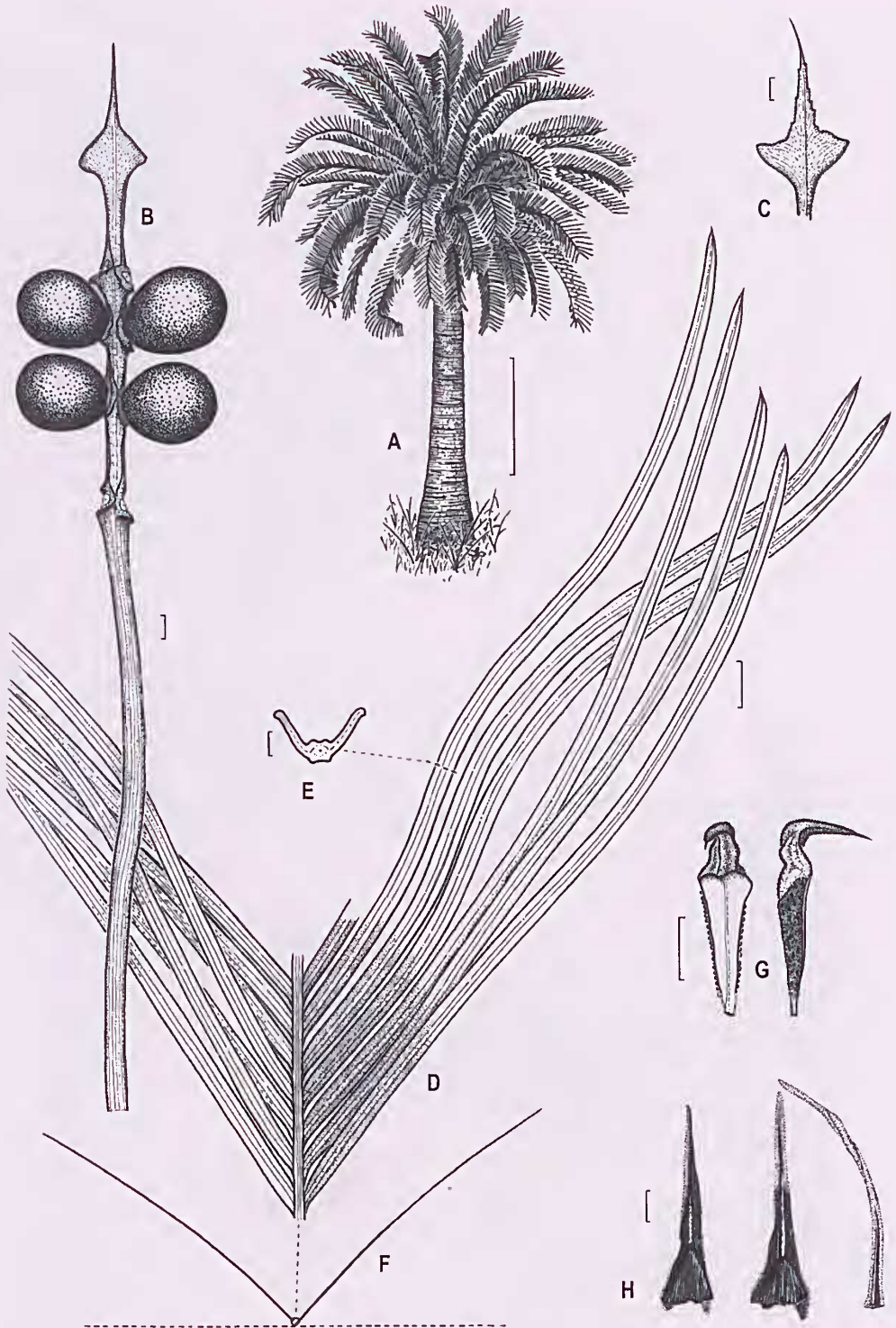


Fig. 5. A-H. *Cycas angulata*. A, habit (DNA slide collection, Manangora Station); B, megasporophyll (Must 1088); C, megasporophyll lamina variation (Maconochie 2045); D, mid portion of leaf and E, C.S. of pinna (Michel 1684); F, C.S. of leaf (GBDBG living collection 94-B000425-4); G, microsporophyll (Byrnes 2782); H, cataphylls (GBDBG living collection 02-664-1). Scale bars: A = 1 m, B-D, G, H = 1 cm, E = 1 mm.

September 1994, *Robertson, R.M.* 6 (DNA); Moonlight Gorge, Wollgorang, 17 September 1994, *Robertson, R.M.* 8 (DNA); 4 km S Spear Waterhole, Wollgorang, 23 January 1989, *Russell-Smith, J.* 6857 (DNA).

Description. *Stems* to 8 m (12 m) tall. *Leaves* 100–160 cm long, with 170–360 pinnae, deeply keeled in cross section, rachis terminated either by a spine or pinnae. *Petiole* 27–42 cm long unarmed or 11–79% spinescent, base and remainder grey-brown tomentose, glabrescent. *Basal* pinnae not gradually reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 4.6–8.5 mm along rachis. *Median* pinnae 126–264 mm long, 4.5–6 mm wide, abaxial surface brown, grey-brown, or grey pubescent, glabrescent, pinnae midrib to rachis angle 38°–64°, slightly keeled in cross section, margins flat to slightly recurved, bases narrowed to 3–4.5 mm, slightly decurrent for 1–2.5 mm, apex pungent, midrib slightly depressed or flat above, raised and prominent below, pinnae spaced at 1–3 mm along rachis, becoming more crowded towards apex. *Cataphylls* hard, pungent, to 13 cm long, densely orange tomentose. *Pollen* cones globose to subglobose, 20–25 cm long, 12–15 cm in diameter, lamina 45–60 mm long, 15–20 mm wide, apical spine 20–30 mm long, sharply upturned. *Megasporophylls* 25–60 cm long with 6–12 ovules, lamina 50–83 mm long, 24–39 mm wide, apical spine 26–37 mm long, margin dentate with 6–36 teeth to 2 mm long, brown, grey-brown, or grey tomentose, glabrescent. *Seeds* 36–49 mm long, 30–44 mm in diameter, pruinose.

Distribution. *Cycas angulata* is known to occur in three populations. In the Northern Territory, specimens have been collected from the Borroloola area and Wollgorang Station (Fig. 4), and in Queensland from Bountiful Island.

Notes. This species is the most robust of the Northern Territory *Cycas*, with some individuals reported to reach a height of 12 metres. Developing leaves and sporophylls of *C. angulata* are brown tomentose; however, at maturity, and with increasing age, the density of the tomentum diminishes so that each organ may appear glabrous. The colour of the hairs fade to grey or light brown-orange with age. Parts of the plant with less exposure to the elements such as the bases of petioles and megasporophylls retain some degree of tomentum.

Hill (1992) distinguished *Cycas brunnea* from *C. angulata* by the broader, flatter pinnae with margins less recurved, the pinnae more widely spaced, the leaves and seeds generally more strongly glaucous, and the smaller seeds. In assessing specimens held at DNA of both these taxa, clear differences that adequately define the purported populations of *C. brunnea* in the Northern Territory could not be identified. Thus *C. brunnea* is not considered to occur in the Northern Territory.

Cycas arenicola K.D. Hill

(Figs 6, 7A–F)

Cycas arenicola K.D. Hill, *Telopea* 5: 419 (1993).

Type: upper East Alligator River, N.T., 7 September 1991, *J. Russell-Smith 8502* and *J. Brock*; holo NSW n.v.; iso: DNA.

Other specimens examined. (selection only, 11 collections seen). Australia. Northern Territory: upper East Alligator River, 4 June 1996, *Liddle, D.T. 1515* and *Anderson, H.* (DNA); Arnhem Escarpment, upper East Alligator River, 21 June 1996, *Michell, C. 235* and *Knox, S.F.* (DNA); East Alligator River, dissected sandstone escarpment, 12 May 1997, *Short, P.S. 4629* and *Mangion, C.P.* (DNA).

Description. *Stems* to 2 m tall. *Leaves* 93–163 cm long, with 176–254 pinnae, flat to slightly keeled in cross section, rachis terminated by pinnae. *Petiole* 15–37 cm long, 33–82% spinescent, base orange-grey velvety, orange-grey tomentose along petiole, glabrescent. *Basal* pinnae not gradually reducing to spines although the basal 2–3 pairs of pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 8–13.6 mm along rachis. *Median* pinnae 98–168 mm long, 3.5–6.5 mm wide, abaxial surface orange or orange-grey tomentose, adaxial surface glabrous, pinnae midrib to rachis angle 46°–58°, slightly keeled in cross section, margins strongly recurved, occasionally revolute, bases narrowed to 1.8–3.5 mm, slightly decurrent for 2–4.5 mm, apex pungent, midrib depressed above, raised and prominent below, pinnae spaced at 3–8 mm along rachis. *Cataphylls* not seen. *Pollen* cones fusiform to 25 cm long, 5–9 cm in diameter, lamina 15–20 mm long, 6–9 mm wide, apical spine 3–5 mm long, sharply upturned. *Megasporophylls* 17–21 cm long with 2–6 ovules, lamina

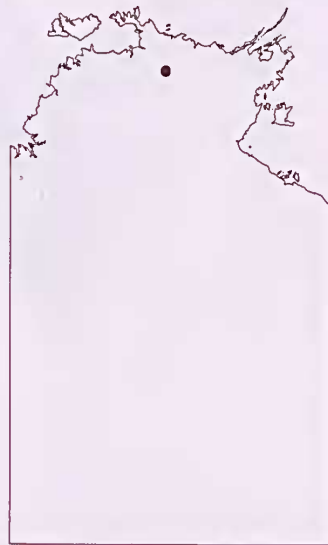


Fig. 6. Distribution of *Cycas arenicola* in the Northern Territory.

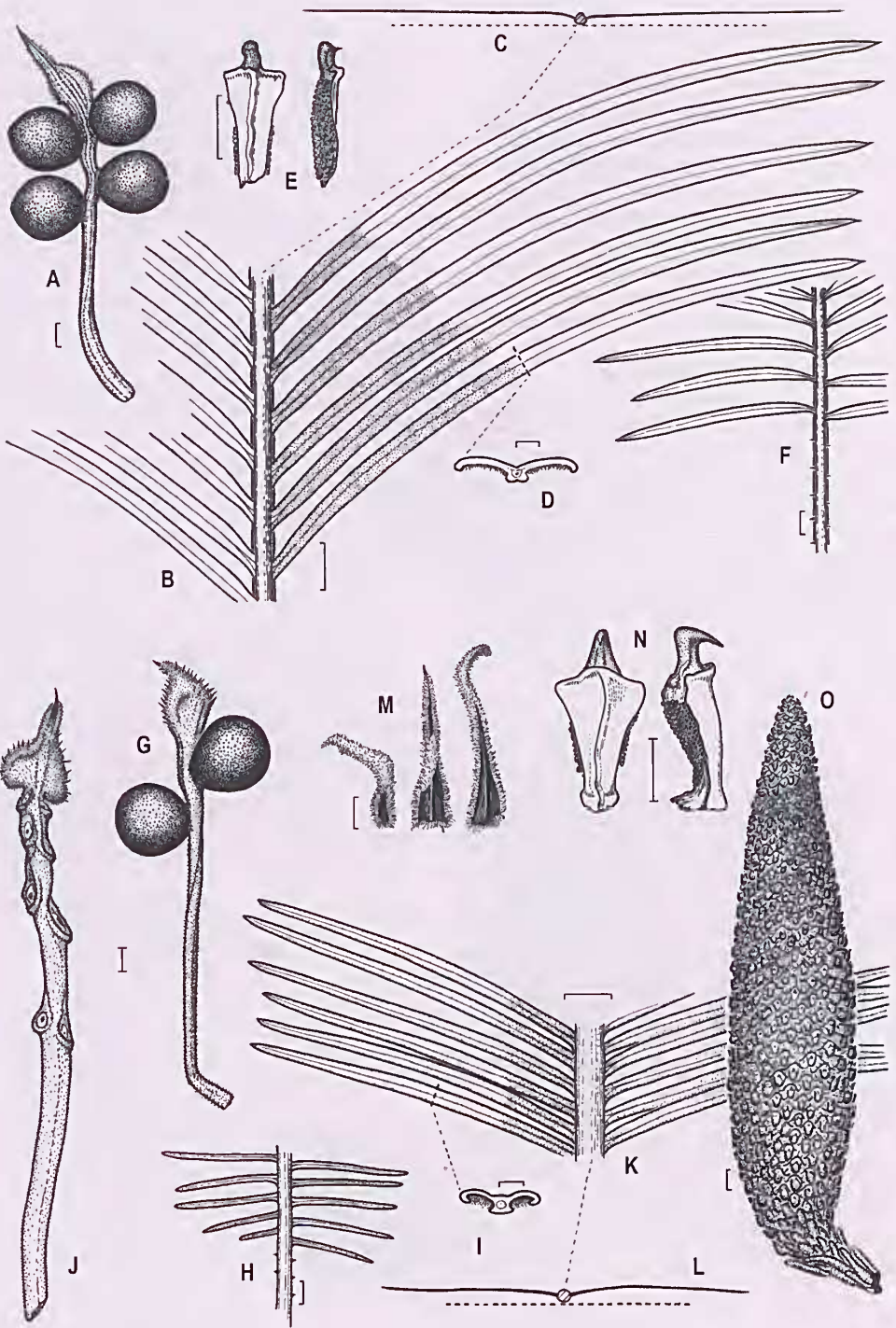


Fig. 7. A-F. *Cycas arenicola*. A, megasporophyll (Michell 235); B, mid portion of leaf; C, C.S. of leaf, and D, C.S. of pinna (Russell-Smith 3867); E, microsporophyll (Liddle 1514); F, base of leaf (Russell-Smith 3867). G-O. *Cycas calcicola*. G, megasporophyll; H, base of leaf, and I, C.S. of pinna (Dixon 913); J, megasporophyll variation (Liddle 1667); K, mid portion of leaf and L, C.S. of leaf; M, cataphylls; N, microsporophyll (Dixon 1077); O, pollen-cone (Hope 3). Scale bars: A, B, E-H, J-N = 1 cm; D, I = 1 mm.

17–47 mm long, 14–26 mm wide, apical spine 12–22 mm long, margin dentate with 13–34 teeth to 5.6 mm long, orange-grey velvety. *Seeds* 28–35 mm long, 25–31 mm in diameter, pruinose.

Distribution. *Cycas arenicola* is endemic to the N.T., with populations recorded from the upper East Alligator and Liverpool Rivers (Hill 1996) (Fig. 6).

Notes. Only occurring on rocky escarpments, *C. arenicola* is easily distinguished from its close relative *C. calcicola* by the less densely tomentose and wider pinnae, pinnae margins recurved not revolute, and the more widely spaced ultimate basal pinnae. Because of its remote and inaccessible locality this species is rarely collected.

Cycas armstrongii Miq.

(Figs 8, 9A–H)

Cycas armstrongii Miq., *Arch. Néerl. Sci. Exact. Nat.* 3(5): 235 (1868); *Cycas media* var. *inermis* A.DC., *Prodr.* 16(2): 528 (1868); *Cycas media* f. *inermis* Miq. *Arch. Néerl. Sci. Exact. Nat.* 3(5): 235 (1868).

Type: Port Essington, N.T. *J. Armstrong* 380; syn: K n.v., U (photo seen).

Other specimens examined. (selection only, 73 collections seen). Australia, Northern Territory: Melville Island, 12 km N of Pularumpi, 10 October 1995, *Barritt, M.J.A.* 1948 (DNA); near Brocks Creek, 5 June 1946, *Blake, S.T.* 16330 (BRI, DNA); Noonamah, 13 January 1972, *Byrnes, N.B.* 2456 (BRI, CANB, DNA, L); Cape Hotham Reserve; Escape Cliff, 30 March 1993, *Cowie, J.D.* 3306 (DNA, NSW); Litchfield National Park, just N of main entrance, 19 September 2002, *Dixon, D.J.* 1055 and *Hope, A.M.* (BRI, DNA, K); Bathurst Island, Big Pig Jungle, 13 June 2001, *Dixon, D.J.* 953 and *Risler, J.* (DNA); 7.5 miles E of Stuart Highway on Humpty Doo road, 17 December 1964, *Hooke, F.G. s.n.* (DNA); 11 miles SE of Darwin, 29 May 1974, *Jacobs, S.W.L.* 1747 (DNA, NSW); Cobourg Peninsula, Port Essington; 45 minute walk NE of Seven Spirit Bay, 15 June 1995, *Larcombe, D.R.* 136 (DNA, MEL, NSW); 40 miles S of Darwin, 10 June 1971, *Maconochie, J.R.* 1310 (AD, BRI, CANB, DNA, K, MEL, NSW, PERTH); Stuart Highway; 48 miles S of Darwin, 10 June 1971, *Maconochie, J.R.* 1312 (AD, DNA, NSW, PERTH); 3 miles NE of Batchelor, 23 September 1971, *Maconochie, J.R.* 1317 (CANB, DNA, K, L); Wild Boar Abattoirs, 1 July 1972, *Maconochie, J.R.* 1620 (BRI, CANB, DNA, K); Howard River - Gunn Point, 2 May 1996, *Michell, C.R.* 76 (DNA); Howard Springs, 1 January 1971, *Morgan, D.J.* 29 (DNA); Darwin, Moil, 9 January 1971, *Morgan, D.J.* 32 (DNA); 58 miles S of Darwin on Stuart Highway, 30 July 1971, *Must, J.* 733 (DNA); Mount Bunday Training Centre, 24 April 1996, *Otley, H. s.n.* (DNA).

Description. *Stems* to 6 m tall. *Leaves* 44–94 cm long, with 84–156 pinnae, flat to slightly keeled in cross section, rachis terminated by a spine. *Petiole* 12–30

cm long unarmed or 5–84% spinescent, base orange-grey tomentose, grey tomentose along petiole, glabrescent. *Basal* pinnae not gradually reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 7.5–17.7 mm along rachis. *Median* pinnae 74–182 mm long, 3.6–8.8 mm wide, shiny, abaxial surface glabrous or orange-brown pubescent, glabrescent, pinnae midrib to rachis angle 56°–70°, flat to very slightly keeled in cross section, margins flat, bases narrowed to 2.3–4 mm, slightly decurrent for 1.5–6 mm, apex pungent, midrib equally prominent above and below, pinnae spaced at 2.8–7 mm along rachis. *Cataphylls* hard, pungent, to 11 cm long, densely orange tomentose, glabrescent. *Pollen* cones ovoid, 12–23 cm long, 7–9 cm in diameter, lamina 20–27 mm long, 12–20 mm wide, apical spine 11–17 mm long, sharply upturned. *Megasporophylls* 12–25 cm long with 1–5 ovules, lamina 11–47 mm long, 10–33 mm wide, apical spine 14–38 mm long, margin dentate with 4–26 teeth to 6 mm long, orange fading to grey tomentose, glabrescent. *Seeds* 29–43 mm long, 26–38 mm in diameter, not pruinose.

Distribution. Endemic to the N.T., and a very common species in the greater Darwin area. *Cycas armstrongii* also occurs on the Cox Peninsula, Tiwi Islands and Cobourg Peninsula (Fig. 8).

Notes. In stature, *C. armstrongii* is one of the smallest *Cycas* species in the Northern Territory. Newly emerging leaves are light orange-brown tomentose, becoming glabrous-glabrescent at maturity. Hybrids between *C. armstrongii* and *Cycas conferta* Chirgwin, and *C. armstrongii* and *Cycas maconochiei* Chirgwin and K.D. Hill have been recorded where their ranges

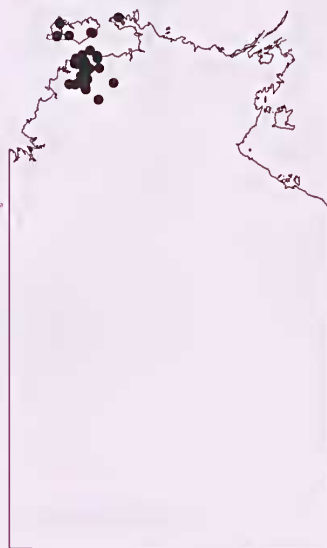


Fig. 8. Distribution of *Cycas armstrongii* in the Northern Territory.

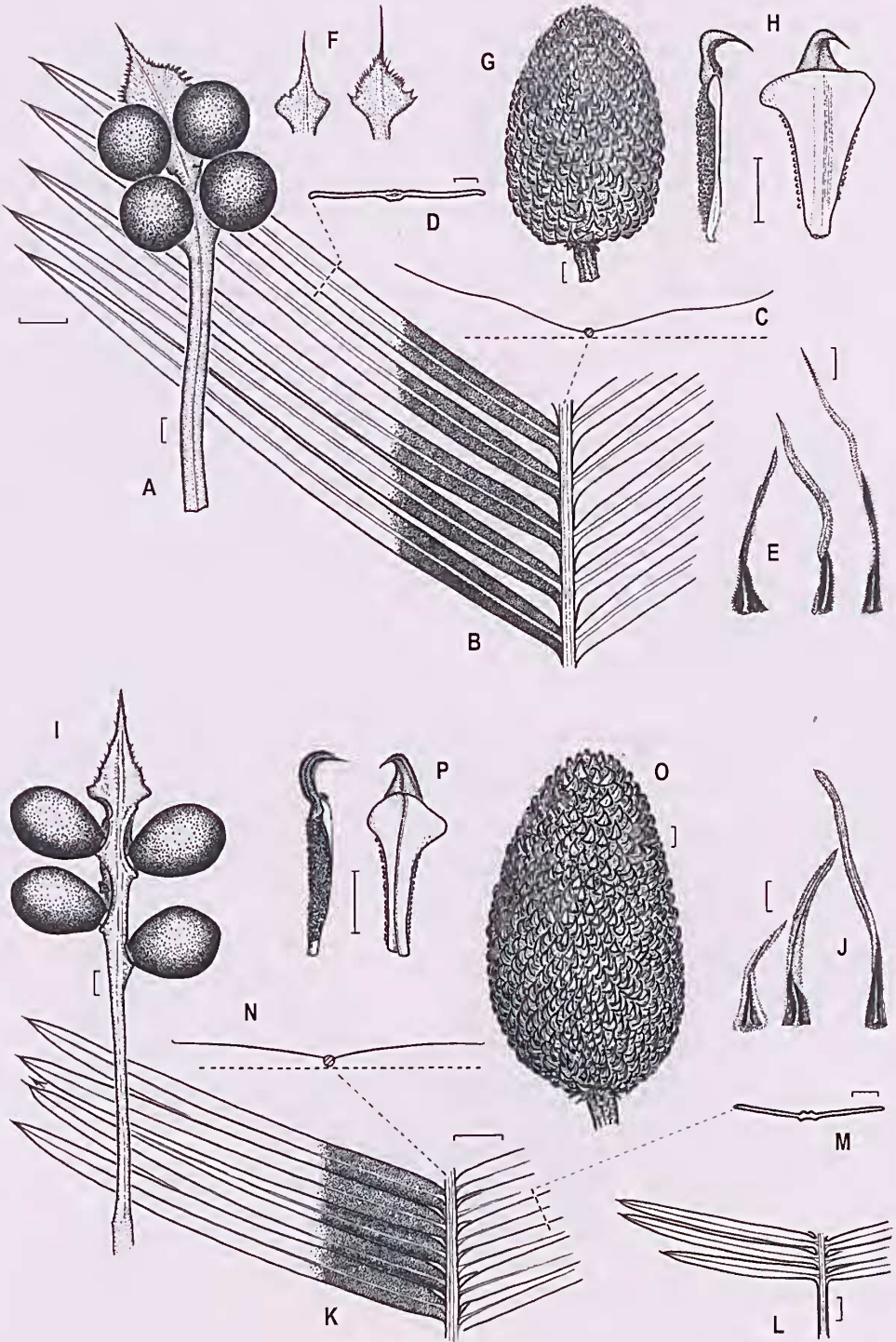


Fig. 9. A-H. *Cycas armstrongii*. A, megasporophyll; B, mid portion of leaf; C, C.S. of leaf; D, C.S. of pinna; and E, cataphylls (Dixon 1073); F, megasporophyll variation (Byrnes 2456 and Maconochie 1311); G, pollen-cone and H, microsporophyll (Maconochie 1318). I-P. *Cycas conferta*. I, megasporophyll and J, cataphylls (Dixon 914); K, mid portion and L, base of leaf; M, C.S. of pinna (Brown 1); N, C.S. of leaf (Dixon 1076); O, pollen-cone and P, microsporophylls (Hope 7). Scale bars: A, B, E, G-L, O, P = 1 cm; D, M = 1 mm.

overlap (Hill and Osborne 2001). Individuals of *C. armstrongii* are often left as remnant plants on recently subdivided land in the greater Darwin area.

The type of *C. armstrongii* is cited by Miquel (1868) as 'In Nova Hollandia boreali ad portum Essington legit Armstrong n. 380 herb. Hookeri.'. Hill (1996) in his taxonomic revision, having not seen any recent collections from the type locality, stated that '*C. armstrongii* has a limited natural distribution, occurring only in the Darwin district, and the type must have originated from there, considerably to the west of the Port Essington settlement site'. *Cycas armstrongii* has recently been rediscovered from the type locality as provided by Miquel (1868) (see specimens examined, Larcombe 136).

Cycas arnhemica K.D. Hill

(Figs 10, 11A–G, Table 1)

Cycas arnhemica K.D. Hill, *Telopea* 5: 693 (1994).

Type: Goyder River crossing, Arnhem Land, N.T., 16 June 1977, J.R. Maconochie 1477; holo: NSW *n.v.*; iso DNA.

Cycas arnhemica subsp. *muninga* Chirgwin and K.D. Hill, *Telopea* 7: 44 (1996). **Type:** 2 km S of Malgala Ck, Groote Eylandt, N.T., 11 September 1991, I. Cowie 2030 and P. Brocklehurst; holo: NSW *n.v.*; iso: BRI *n.v.*, CANB *n.v.*, DNA, K *n.v.*, MEL *n.v.*, NSW *n.v.*, PERTH *n.v.*.

Cycas arnhemica subsp. *natja* K.D. Hill, *Telopea* 7: 46 (1996). **Type:** Blyth River crossing, east bank, Arnhem Land, N.T., 6 September 1972, B. Meehan 56; holo: DNA.

Other specimens examined. (selection only, 74 collections seen). Australia, Northern Territory: Arnhem Land, 92.4 km E of Maningrida turnoff on Bulman road, 20 September 1987, Clark, M.J. 1358 (DNA); 261.4 km SW of Nhulunbuy on Central Arnhem Highway, 28 November 2002, Dixon, D.J. 1067 and Rochford, D.C. (DNA, K); Mudcod Bay, Groote Eylandt, 1 August 1972, Dunlop, C.R. 2955 (DNA, K); 1 km N of Gamardi Outstation on road to Yilan Outstation, 5 June 2002, Griffiths, A.J. 3 (DNA); 13.2 km E of Ramingining turnoff on Gove road, 25 August 1991, Hill, K.D. 3919 and Stanberg, L. (CANB, DNA, NSW); 5.6 km W of Blyth River crossing on Ramingining - Maningrida road, 1 September 1991, Hill, K.D. 3991 and Stanberg, L. (CANB, DNA, NSW); W side of Mitchell Ranges, 5 December 1994, Larcombe, D.R. 127 and Panton, W.J. (DNA); 60 km SE of Maningrida, 26 km W of Ramingining airstrip, 10 July 1996, Liddle, D.T. 1588 (BRI, DNA); 7.5 km NW of Old Arafura, located near the junction of the Goyder and Glyde rivers, 10 July 1996, Liddle, D.T. 1592 (BRI, DNA, MO); central Arnhem Land, 6.2 km E of the Goyder River crossing, beside Nhulunbuy road, 2 August 1996, Liddle, D.T. 1663 (BRI, DNA); Ramingining Airstrip, Arnhemland,

1 July 1975, Maconochie, J.R. 2073 (DNA); Elcho Island, 7 July 1975, Maconochie, J.R. 2133 (CANB, DNA, K); Donydji, E Arnhem Land, 10 August 1976, Scarlett, N.H. 12 (DNA); Annie Creek Springs, Arnhem Land, 11 September 1985, Wightman, G.M. 2226 (DNA); Arnhem Land, Milingimbi, Wumila, 13 April 1988, Wightman, G.M. 4381 (DNA).

Description. *Stems* to 5 m tall. *Leaves* 52–116 cm long, with 98–262 pinnae, flat to slightly keeled in cross section, rachis terminated either by a spine or pinnae. *Petiole* 14–38 cm long unarmed or 2–74% spinescent, base orange woolly, grey tomentose extending a short way up the petiole, glabrescent. *Basal pinnae* not gradually reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, or very rarely gradually reducing to spines, basal pinnae spaced at 3–9.3 (13) mm along rachis. *Median pinnae* 75–175 mm long, 3–7 mm wide, abaxial surface light brown pubescent, glabrescent, pinnae midrib to rachis angle 48°–80°, keeled in cross section, margins strongly recurved, rarely revolute, bases narrowed to 2.3–6 mm, slightly decurrent for 0.5–4 mm, apex pungent, midrib slightly depressed or flush above, raised and prominent below, spaced at 1.5–6.5 mm along rachis. *Cataphylls* soft and fleshy, not pungent, densely orange-grey tomentose. *Pollen cones* ovoid, 15–36 cm long, 6–12 cm in diameter, lamina 16–36 mm long, 9–18.5 mm wide, apical spine 7–15 mm long, sharply upturned. *Megasporophylls* 12–25 cm long with 1–6 ovules, lamina 28–48 mm long, 10–25 mm wide, apical spine 9.5–31 mm long, margin dentate with 4–36 teeth to 2.8 mm long, or entire, orange tomentose, blade often grey tomentose. *Seeds* 28–36 mm long, 25–30 mm in diameter, not pruinose or occasionally slightly pruinose.

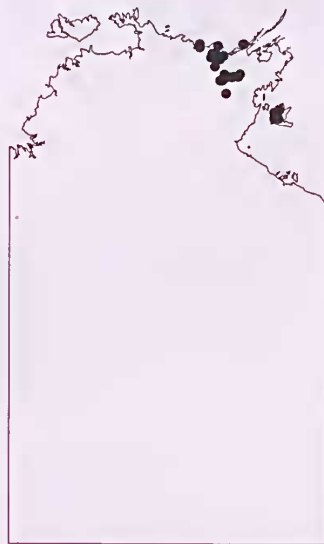


Fig. 10. Distribution of *Cycas arnhemica* in the Northern Territory.

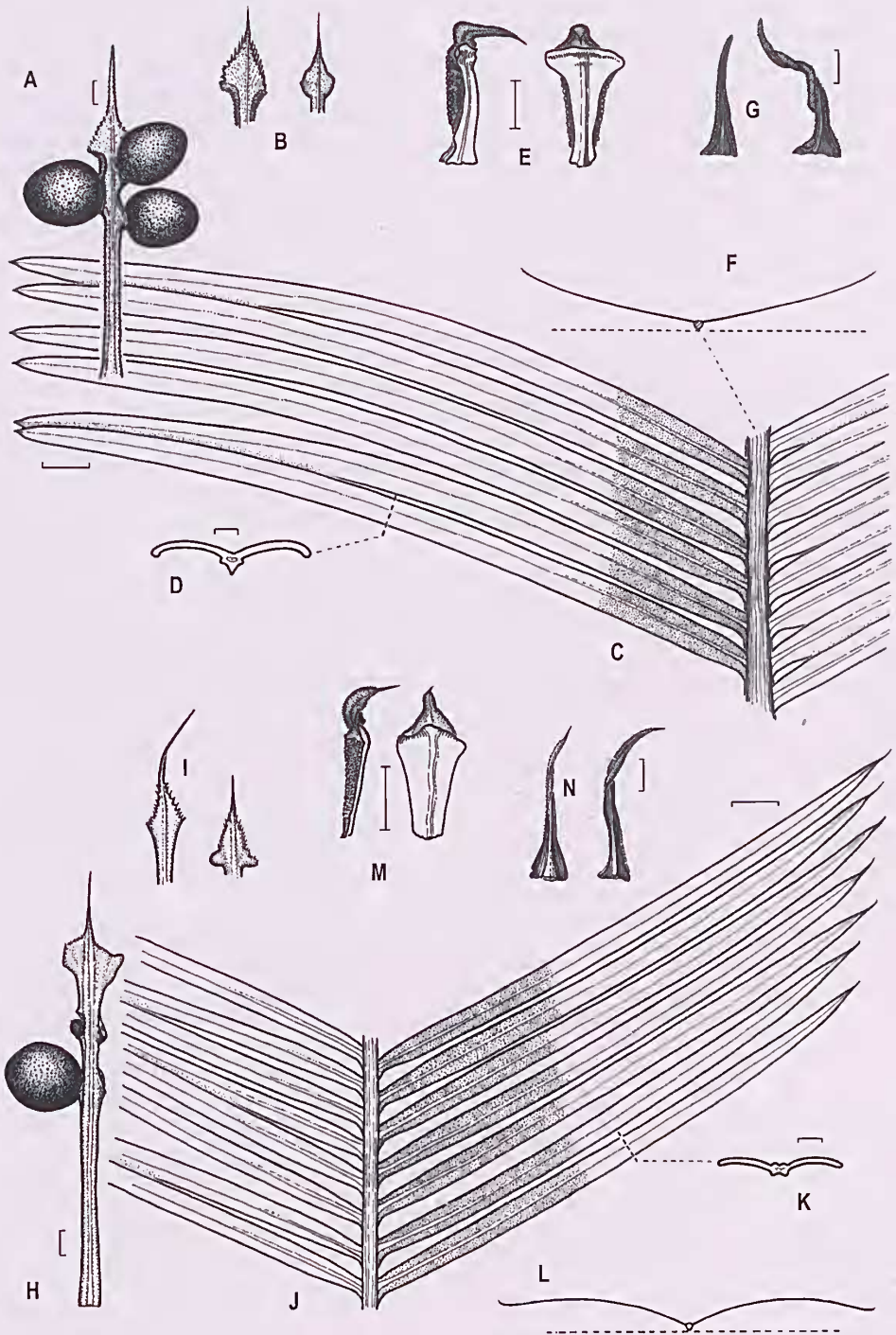


Fig. 11. A-G. *Cycas arnhemica*. A, megasporophyll (Maconochie 1465); B, megasporophyll variation (Liddle 1663 and Dixon 1067); C, mid portion of leaf; D, C.S. of pinna and E, microsporophyll (Liddle 1665); F, C.S. of leaf (GBDBG Living collection 02-B000644-1); G, cataphylls (Dixon 1068). H-N. *Cycas orientis*. H, megasporophyll (Maconochie 1511); I, megasporophyll variation (Maconochie 1516 and Liddle 1662); J, mid portion of leaf and K, C.S. of pinna (Liddle 1662); L, C.S. of leaf (GBDBG living collection 02-B000647); M, microsporophyll (Liddle 1657); N, cataphylls (Dixon 1072). Scale bars: A, C, E, G, H, L, M = 1 cm; D, K = 1 mm.

Distribution. *Cycas arnhemica* is endemic to the N.T., where it occurs in two populations, one in central northern Arnhem Land with extensions to offshore islands, and the other on Groote Eylandt (Fig. 10).

Notes. *Cycas arnhemica* is most often found in open eucalypt woodland on yellow sand or old beach dunes. Newly emerging growth is orange-brown tomentose, soon becoming almost glabrous. The hairs also fade to grey with age. Individuals of *Cycas orientis* K.D. Hill have been recorded from within the range of *C. arnhemica* in central Arnhem Land, but can be distinguished from the former by the recurved margins of the pinnae.

Three subspecies, *C. arnhemica* subsp. *arnhemica*, *C. arnhemica* subsp. *muninga* Chirgwin and K.D. Hill, and *C. arnhemica* subsp. *natja* K.D. Hill have previously been recognised by Hill (1996) for this taxon. The characters used by Hill (1996) to differentiate the subspecies, together with measurements taken from additional material held at DNA were found to overlap enough to preclude reliable identification at subspecific level (Table 1).

Table 1. Comparison of morphological characters of the *Cycas arnhemica* subspecies recognised by Hill (1996). Key determining characters used by Hill (1996) are in bold.

Character	<i>arnhemica</i>	<i>muninga</i>	<i>natja</i>
Pinnae spacing	2.4–6.4 mm	2–5 mm	1.5–6.5 mm
Pinnae width	4.9–7.0 mm	3.0–5.8 mm	3.0–5.3 mm
Pinnae margin	Recurved	Recurved	Recurved
Pinnae length	109–158 mm	75–175 mm	75–123 mm
Pinnae (cross section)	Keeled	Keeled	Keeled
Pinnae angle of insertion	48–73°	63–76°	66–80°
Male cone length	15–23 cm	25–36 cm	19–22 cm
Pollen conc diameter	6–8 cm	8–12 cm	8–9 cm
Seed length	28–36 mm	31–35 mm	31–33 mm
Seed diameter	25–30 mm	26–30 mm	26–30 mm

Cycas calcicola Maconochie

(Figs 7G–O, 12)

Cycas calcicola Maconochie *J. Adelaide Bot. Gard.*

1: 175 (1978).

Type: 16 km N of Katherine, N.T., 10 June 1971, *J.R. Maconochie 1314*; holo: DNA; iso: BRI *u.v.*, CANB *u.v.*, K *u.v.*, L *u.v.*, PERTH *u.v.*

Other specimens seen. (selection only, 82 collections examined). Australia, Northern Territory: 10 km N of Katherine along Stuart Highway, 12 June 1994, *Brennan, K.G. 2858* (DNA); Walker's Creek, Litchfield Park, 7 December 1986, *Brock, J. 176* (DNA); Black Fellow Creek, 18 December 1968, *Byrnes, N.B. 1240* (DNA); Tolmer Falls, Litchfield National Park, 5 October 2001, *Dixon, D.J. 911 and Hope, A.M.* (BRI, DNA); Spirit Hills, 9 May 1995, *Dunlop, C.R. 10159 and Walsh, B.* (BRI, DNA, NSW); Litchfield National Park, Tolmer Falls, c.100m from the car park, 5 October 2001, *Hope,*

A.M. 3 and Dixon, D.J. (DNA, NSW); Fish River Station, mid slope of jump-up on road to Daly River, 10 September 2001, *Kerrigan, R.A. 407* (DNA); Kintore Caves Conservation Reserve, 23 August 1996, *Liddle, D.T. 1667* (BRI, DNA, NSW); Litchfield National Park, Bamboo Creek Cycad site 17, 9 April 2001, *Liddle, D.T. 2643 and Harwood, R.K.* (DNA); Spirit Hills escarpment rift valley, 19 Aug 1996, *Michell, C.R. 271 and Butler, W.H.* (DNA); Hill 600 m E of Daly River Police Station, 1 May 1993, *Perner, J. s.u.* (DNA); 3 km W Mt Muriel, Tipperary, 16 March 1989, *Russell-Smith, J. 7896 and Brock, J.* (DNA); Katherine Gorge National Park, 27 April 1977, *Wood, A. s.n.* (DNA).

Description. *Stems* to 3 m tall. *Leaves* 58–135 cm long, with 198–504 pinnae, flat in cross section, rachis terminated either by a spine or pinnae. *Petiole* 10–33 cm long, 6–82% spinescent, base orange woolly, grey tomentose extending a short way up the petiole, glabrescent. *Basal* pinnae gradually or not gradually reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 2–6.8 mm along rachis. *Median* pinnae 55–140 mm long, 1.7–3.7 mm wide, abaxial surface light grey-orange tomentose, pinnae midrib to rachis angle 60°–74°, keeled in cross section, margins revolute, bases narrowed to 1.8–3 mm, slightly decurrent for 0.5–1.5 mm, apex pungent, midrib slightly depressed, flush, or occasionally raised above, raised and prominent below, pinnae spaced at 1.4–4.2 mm along rachis. *Cataphylls* soft, not pungent, densely orange woolly. *Pollen* cones fusiform, 20–29 cm long, 4–7 cm in diameter, lamina 18.5–25 mm long, 12–16 mm wide, apical spine 2.5–9 mm long, sharply upturned. *Megasporophylls* 14–27 cm long with 1–8 ovules, lamina 30–43 mm long,



Fig. 12. Distribution of *Cycas calcicola* in the Northern Territory.

12–29 mm wide, apical spine 13–23 mm long, margin dentate with 15–26 teeth to 8 mm long, orange woolly. *Seeds* 30–38 mm long, 26–32 mm in diameter, pruinose.

Distribution. *Cycas calcicola* is endemic to the N.T., and is concentrated in the Litchfield, Daly River and Katherine area. A disjunct population occurs in the Spirit Hills Conservation Reserve adjacent to the Keep River National Park (Fig. 12).

Notes. Throughout its range *C. calcicola* is mostly associated with rocky outcrops. Newly emerging leaves are light grey-pale orange tomentose, with the tomentum persisting on the undersurface of mature leaves. Female plants with eight ovules per megasporophyll have been found in the population occurring in the Kintore Caves Conservation Reserve north west of Katherine.

Cycas calcicola is often confused with *Cycas pruinosa* Maconochie where the two occur together in the Spirit Hills area. The leaves of *C. calcicola* are flat in cross section as opposed to *C. pruinosa*, where the leaves are deeply keeled in the distal 2/3 of the leaf. The abaxial surface of the pinnae are tomentose in *C. calcicola* and pubescent in *C. pruinosa*. Natural hybrids between *C. calcicola* and *C. conferta* have been recorded at Blackfellow Creek area by Hill and Osborne (2001). Despite occurring together in the Spirit Hills area, no hybrids between *C. calcicola* and *C. pruinosa* have been recorded.

Cycas canalis K.D. Hill

(Figs 13, 14A–I, Table 2)

Cycas canalis K.D. Hill, *Telopea* 5: 698 (1994).

Type: 31.4 km from Labelle Downs Homestead on track to Channel Point, N.T., 8 September 1991, *K.D. Hill 4034* and *L. Stanberg*; holo: NSW; iso: CANB *n.v.*, DNA *n.v.*

Cycas canalis subsp. *carinata* K.D. Hill, *Telopea* 5: 700 (1994). **Type:** 90 km from Stuart Highway on Dorisvale Road, N.T., 11 September 1991, *K.D. Hill 4063* and *L. Stanberg*; holo: NSW.

Other specimens examined. (selection only, 18 collections seen). Australia. Northern Territory: Labelle Downs Homestead, on track to Channel Point, 15 November 2002, *Dixon, D.J. 1058* and *Oiley, H.* (BRI, DNA, K); Douglas Hot Springs, 5 October 2001, *Dixon, D.J. 917* and *Hope, A.M.* (DNA); 64 km NE Daly River Police Station, 22 May 1983, *Fryxell, P.A. 4252* and *Craven, L.A.* (CANB, DNA); 50.1 km from Labelle Downs Homestead on track to Channel Point, 8 September 1991, *Hill, K.D. 4038* and *Stanberg, L.* (NSW); Road to Douglas Hot Springs, 9 September 1993, *Hill, K.D. 4505* and *Perner, J.* (NSW); Flora River Conservation Reserve, just outside boundary fence, 10 October 1996, *Mangion, C.P. 362* and *Booth, R.* (DNA); 0.5 km W of Daly River crossing, Dorisvale Road, 13 October 1993, *Perner, J. s.n.* (NSW); 2 km NE of Dorisvale, 30 November 1978, *Rankin, M.O. 1664* (DNA).

Description. *Stems* to 5 m tall. *Leaves* 65–93 cm long, with 86–146 pinnae, flat to slightly keeled in cross section, rachis terminated by a spine, rarely a pair of leaflets. *Petiole* 19–27 cm long unarmed or 45–82% spinescent, base orange-grey tomentose, grey tomentose along petiole, glabrescent, glaucous. *Basal pinnae* not gradually reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 9.7–19.7 mm along rachis. *Median pinnae* 88–243 mm long, 5–7.4 mm wide, glabrous with a few scattered hairs at base, pinnae midrib to rachis angle 44°–69°, flat to very slightly keeled in cross section, margins flat, bases narrowed to 2–3.4 mm, decurrent for 2–5 mm, apex pungent, midrib equally prominent above and below, or slightly sunken on adaxial surface, pinnae spaced at 2.9–8 mm along rachis. *Cataphylls* hard, pungent to 80 mm long, densely orange woolly. *Pollen cones* ovoid, 11.8–22.5 cm long, 6.4–10.5 cm in diameter, lamina 26–35 mm long, 8–20 mm wide, apical spine 9–13 mm long, sharply upturned. *Megasporophylls* 16–22.2 cm long with 2–4 ovules, lamina 15–42 mm long, 12–28 mm wide, apical spine 10–21 mm long, margin entire or dentate with 6–21 teeth to 3 mm long, base orange fading to grey tomentose, stipe glabrescent, lamina orange fading to grey tomentose. *Seeds* 33–42 mm long, 28–34 mm in diameter, slightly pruinose/glaucous.

Distribution. *Cycas canalis* is an endemic N.T. species found in the Flora River area south-west of Katherine, Douglas-Daly region and Channel Point on Labelle Downs (Fig. 13).

Notes. *Cycas canalis* may be confused with *C. armstrongii*. The two species can be distinguished easily as *C. armstrongii* has green glossy mature leaves

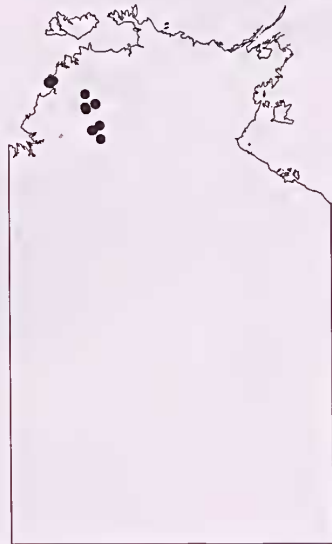


Fig. 13. Distribution of *Cycas canalis* in the Northern Territory.

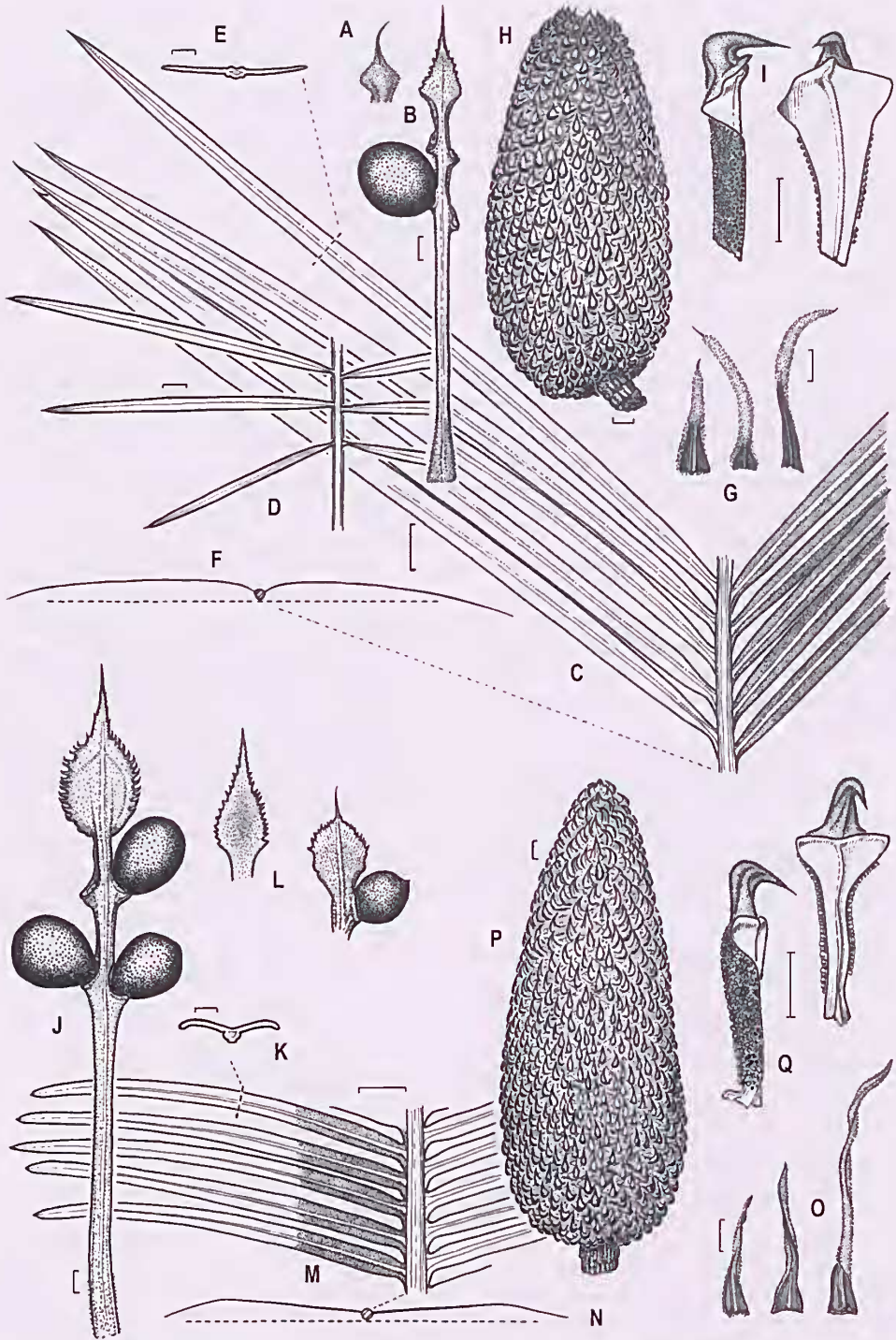


Fig. 14. A-I. *Cycas canalis*. A, megasporophyll (Dixon 1062); B, megasporophyll variation (Dixon 1058); C, mid portion and D, base of leaf; E, C.S. of pinna (Dixon 1059); F, C.S. of leaf (GBDBG living collection 01-B000393); G, cataphylls (GBDBG living collection 01-B000393 and Dixon 1061); H, pollen-cone and I, microsporophylls (Dixon 1061). J-Q. *Cycas macouochiei* subsp. *macouochiei*. J, megasporophyll and K, C.S. of pinna (Dixon 918); L, megasporophyll variation (Hope 14 and Dixon 1075); M, mid portion and N, C.S. of leaf (Dixon 1075); O, cataphylls (Dixon 920 and 1075); P, pollen-cone and Q, microsporophyll (Hope 16). Scale bars: A-D, F-J, L-Q = 1 cm; E, K = 1 mm.

compared to the bluish-glaucous leaves of *C. canalis*. Seed of *C. canalis* is also slightly glaucous/pruinose. The cataphylls of *C. canalis* are densely covered with orange woolly hairs compared to the tomentose almost glabrous orange-brown cataphylls of *C. armstrongii*.

Hill (1994) recognised two subspecies of *C. canalis* based on differences in the size of the leaf, differences in the pinnae to rachis angle and whether or not the leaves were flat or keeled. *Cycas canalis* subsp. *canalis* according to Hill (1994) could be distinguished by the smaller non-keeled leaves, with smaller pinnae and the high pinna-to-rachis angle. Data obtained from material on loan from NSW and recent collections from the populations of *C. canalis* (Table 2) revealed that these distinguishing characters do not allow for adequate determination at the subspecific level. When the distribution data is plotted (Fig. 13), the Channel Point population is separated from the Douglas-Daly population by the Daly River and Reynolds River floodplain (Floodplain #4 in Cowie *et al.*, 2000) which explains the disjunct populations of the species.

Table 2. Comparison of key determining characters used in Hill (1994) to distinguish the subspecies of *Cycas canalis*.

Subspecies determined on sheet	Collector	Leaf length	Median pinnae length	Pinnae angle to rachis
<i>carinata</i>	Mangion 362	92.2 cm	18.9 cm	55°
<i>carinata</i>	Perner s.n.	88.1 cm	13.7 cm	53°
<i>carinata</i>	Hill 4505	90.7 cm	8.8 cm	65°
<i>carinata</i>	Hill 4063	89.1 cm	20.3 cm	52°
<i>carinata</i>	Rankin 1664	–	24.3 cm	49°
<i>carinata</i>	Holmes s.n.	–	10.2 cm	69°
<i>canalis</i>	Dixon 1058	69.6 cm	11 cm	61°
<i>canalis</i>	Dixon 1059	92.4 cm	18.2 cm	48°
<i>canalis</i>	Hill 4038	65.5 cm	14.5 cm	47°
<i>canalis</i>	Dixon 1061	65 cm	18.1 cm	60°

Cycas conferta Chirgwin

(Figs 9I–P, 15)

Cycas conferta Chirgwin, in S.K. Chirgwin and D. Wigston, *J. Adelaide Bot. Gard.* 15: 147 (1993).

Type: Harriet Creek, E of Pine Creek, 21 April 1987, *G. Brown s.n.*; holotype: DNA.

Other Specimens examined. (selection only, 25 collections seen). Australia, Northern Territory: Kakadu National Park, 2.6 km S of South Alligator River crossing on Kakadu Highway, 2 September 1991, *Brennan, K.G. 1377* (DNA); N of Foelsche Headland off Claravale road, 11 November 1989, *Clark, M.J. 1925 and Walker, C.* (DNA); Burrell Creek, off scenic Adelaide River route, 24 km SW of Adelaide River, 25 October 2002, *Dixon, D.J. 1056 and Hope, A.M.* (BRI, DNA, K); Harriet Creek rest area off Kakadu Highway, 24.3 km from Stuart Highway, 5 October 2001, *Dixon, D.J. 914 and Hope, A.M.* (BRI, DNA); 19 km E of Pine Creek on Jabiru road, 29 August 1991, *Hill, K.D. 3968 and Stanberg, L.* (CANB, DNA, NSW); 104.2 km from Arnhem Highway

on Kakadu Highway (2.5 km SW of South Alligator crossing), 2 September 1991, *Hill, K.D. 4014 and Stanberg, L.* (CANB, DNA, NSW); 4.6 km from Kakadu Highway on old Goodparla track, 3 September 1991, *Hill, K.D. 4022 and Stanberg, L.* (CANB, DNA, NSW); Kakadu National Park, 14 km E of Gimbat Homestead, 14 December 1994, *Russell-Smith, J. 8996* (DNA); Kakadu National Park, Andinggu, 5 February 1995, *Russell-Smith, J. 9433* (DNA); Kakadu National Park, 4.6 km W on Goodparla road from junction with Kakadu Highway, 29 April 1990, *Slee, A.V. 3035 and Craven, L.* (CANB, DNA).

Description. *Stems* to 6 m tall. *Leaves* 71–91 cm long, with 124–192 pinnae, flat in cross section, rachis terminated by a spine. *Petiole* 24–34 cm long unarmed or 0.1–62% spinescent, base orange tomentose extending a short way up the petiole, glabrescent. *Basal pinnae* not gradually reducing to spines although the basal 1–4 pinnae may be shorter than the preceding pinnae, basal pinnae overlapping or spaced at 0.4–6.6 mm along rachis. *Median pinnae* 49–100 mm long, 4.6–6.6 mm wide, abaxial surface scattered orange pubescent, glabrescent, bluish, pinnae midrib to rachis angle 68°–80°, flat to slightly keeled in cross section, margins flat, bases narrowed to 3.6–5.4 mm, slightly decurrent for 0.5–2 mm, apex pungent, midrib slightly depressed to equally prominent above and below, pinnae overlapping or spaced at 0.8–2.4 mm along rachis. *Cataphylls* hard, pungent, to 9.3 cm long, densely orange tomentose. *Microsporangiate* cones ovoid, 11–27 cm long, 7–10 cm in diameter, lamina 15–34 mm long, 10–13 mm wide, apical spine 6–16 mm long, curved or sharply upturned. *Megasporophylls* 18–28 cm long with 1–4 ovules, lamina 35–42 mm long, 15–26 mm wide, apical spine 10–48 mm long, margin

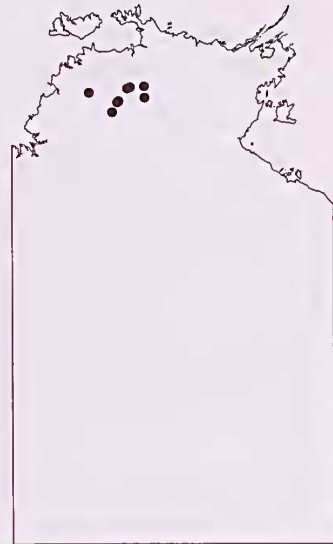


Fig. 15. Distribution of *Cycas conferta* in the Northern Territory.

dentate with 17–25 teeth to 4 mm long, orange-grey tomentose, glabrescent. *Seeds* 35–42 mm long, 27–31 mm in diameter, pruinose.

Distribution. Known previously from sporadic populations around the south Alligator River, Mary River, Foelsche Headland and Pine Creek areas, the range has been extended to include a more easterly population in Kakadu National Park near the Gimbat Homestead and a more northerly population at Burrell Creek, just south of the Adelaide River township (Fig. 15).

Notes. *Cycas conferta* is an attractive endemic Northern Territory, species easily recognised by the crowded bluish green pinnae of the leaves. It occurs in a variety of habitats from open eucalypt woodland on low relief to granite and dolerite outcrops.

Cycas maconochiei Chirgwin and K.D. Hill

Cycas maconochiei Chirgwin and K.D. Hill, *Telopea* 7: 48 (1996).

Type: at Bynoe Harbour turnoff, Mandorah road, N.T., 4 September 1993, *K.D. Hill 4461 and H.M. Anderson*; holotype: NSW *n.v.*; isotype: DNA *n.v.*, NY *n.v.*, PE *n.v.*

Stems to 3.5 m tall. *Leaves* 62–128 cm long, with 152–288 pinnae, flat in cross section, rachis terminated by a spine or pinnac. *Petiole* 16–30 cm long unarmed or 2–79% spinescent, base light orange-brown velvety, orange-grey tomentum extending along the petiole, glabrescent. *Basal* pinnae not gradually reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 4.4–11 mm along rachis. *Median* pinnae 51–157 mm long, 3.4–6 mm wide, abaxial surface orange-brown pubescent or with scattered grey hairs, glabrescent, pinnae midrib to rachis angle 61°–85°, keeled in cross section, margins slightly to distinctly recurved, bases narrowed to 2.5–3.8 mm, slightly decurrent for 0.5–2.5 mm, apex pungent, midrib depressed or flush above and raised and prominent below, pinnae occasionally overlapping or spaced at 1.5–3.9 mm along rachis. *Cataphylls* soft, not pungent, to 13 cm long, densely orange-brown woolly. *Pollen* cones ovoid, 15–27 cm long, 9–11 cm in diameter, lamina 38–41 mm long, 14–15 mm wide, apical spine to 11 mm long, sharply upturned. *Megasporophylls* 16–37 cm long with 2–5 ovules, lamina 40–70 mm long, 14–30 mm wide, apical spine 12–30 mm long, margin dentate with 22–41 teeth to 8 mm long, base orange-grey velvety, stem brown-grey tomentose glabrescent, blade orange-brown-grey tomentose. *Seeds* 27–40 mm long, 26–35 mm in diameter, pruinose.

Notes. *Cycas maconochiei* is a variable species with respect to some of the characters used by Hill (1996) to distinguish between the three subspecies. Hill (1996) used characters associated with pinnac width, pinnac

margin, leaf colour, degree of indumentum retained on a mature leaf and cataphylls, and indumentum colour to distinguish between the three subspecies. The pinnac width of subspecies *maconochiei* and *lanatus* were found to overlap (3.4–6 mm for *maconochiei* and 4.4–5.9 mm for *lanatus*). Colour of the indumentum is also variable with the colour fading on exposed parts of the leaf as it ages. The subspecies *C. maconochiei* subsp. *viridis* can be distinguished by the bright green leaves and its almost glabrous pinnac; however, these can retain some scattered grey hairs at maturity.

The two subspecies of *Cycas maconochiei* can be identified as follows:

- 1a. Mature leaves and pinnae dull green, retaining orange-brown indumentum
..... subsp. *maconochiei*
- 1b. Mature leaves and pinnae glossy green, glabrous or with scattered grey indumentum
..... subsp. *viridis*

Cycas maconochiei Chirgwin and K.D. Hill
subsp. *maconochiei*

(Figs 14J–Q, 16)

Cycas maconochiei subsp. *lanata* K.D. Hill, *Telopea* 7: 49 (1996). **Type:** 25 km E of Port Keats, N.T., 11 October 1980, *J.R. Maconochie 2498*; holotype: DNA; isotype: CANB *n.v.*, K *n.v.*

Other specimens examined. (selection only, 56 collections examined). Australia, Northern Territory: Finnis River Station, 12 August 1997, *Cowie, I.D. 7640 and Mangion, C.P.* (DNA); 1.5 km SW of Mandorah Pub, 19 September 2002, *Dixon, D.J. 1054 and Hope, A.M.* (BRI, DNA, K); 25.2 km along Dundee Beach Road, off Cox Peninsula Road, 12 October 2001, *Dixon, D.J. 918 and Hope, A.M.* (BRI, CANB, DNA); Port Keats, opposite Dorchester Isle, 9 August 1983, *Dunlop, C.R. 6457 and Wightman, G.M.* (DNA); Fitzmaurice River, 10 June 1997, *Fogarty, M.L. s.n. and Beilby, A.M.* (DNA); Near mouth of Daly River; 10 km SSE of Cliff Head, 22 June 1985, *Fryxell, P.A. 4883* (CANB, DNA); Indian Island, 29 September 1997, *Harwood, R.K. 249* (DNA); Plain to N of Wingate Mountains, 10 September 1991, *Hill, K.D. 4054 and Stanberg, L.* (DNA, NSW); Daly River, Port Keats Road, 10 September 1991, *Hill, K.D. 4057 and Stanberg, L.* (NSW); Daly Region, road to Woodycupaldea, 5 September 1993, *Hill, K.D. 4464 and Perner, J.* (DNA, NSW, NY); road to beach N of Nardirri, 6 September 1993, *Hill, K.D. 4466 and Perner, J.* (BRI, CANB, DNA, NSW); 4.4 km from Dundee Beach along Cox Peninsula Road, 12 October 2001, *Hope, A.M. 15 and Dixon, D.J.* (DNA, NSW), 12 km N Dundee Lodge turnoff along Cox Peninsula Road towards Mandorah, 12 October 2001, *Hope, A.M. 22 and Clifton, P.J.* (DNA, NSW); Moyle River, 75 km E of Port Keats, 10 May 1994, *Latz, P.K. 13795 and Dunlop, C.R.* (DNA, NSW); 39 km E Port Keats Mission, 9

October 1980, *Maconochie, J.R. 2495* (PERTH); 5 miles S Mandorah, 12 July 1972, *Must, J. 1076* (CANB, DNA, K, L, MEL, PERTH); Delissaville, 15 September 1972, *Must, J. s.n.* (CANB, DNA, K, MO); S of Palumpa, 1 October 1988, *Orr, T.M. 230* (DNA); Cox Peninsula, Imaluck Jungle, 13 May 1986, *Wightman, G.M. 2907 and Bruhl, J.J.* (DNA); Melville Island, Fort Dundas, 29 May 1986, *Wightman, G.M. 2949* (DNA).

Description. *Leaves* 62–111 cm long, with 152–288 pinnae, rachis terminated by a spine or pinnae. *Petiole* 16–28 cm long unarmed or 4–79% spinescent, base light orange-brown velvety, orange-grey tomentum extending along the petiole, glabrescent. *Median* pinnae with abaxial surface orange-brown pubescent, glabrescent, margins slightly to distinctly recurved, pinnae occasionally overlapping or spaced at 1.5–3.4 mm along rachis.

Distribution. *Cycas maconochiei* subsp. *maconochiei* is an endemic N.T., subspecies found along the coast of the NW Top End and the Tiwi Islands (Fig. 16).

Cycas maconochiei subsp. *viridis* K.D. Hill

(Fig. 16)

Cycas maconochiei subsp. *viridis* K.D. Hill, *Telopea* 7: 51 (1996).

Type: Fossil Head, N.T., 7 September 1993, *K.D. Hill 4489* and *J. Perner*; holo: NSW.

Other specimens examined. (selection only, 11 collections examined). Australia, Northern Territory: Fossil Head, May 1993, *Perner, J. s.n. D159627* (DNA, NSW); Fossil Head, May 1993, *Perner, J. s.n. D159629* (CANB, DNA, NSW); Fossil Head, May 1993, *Perner, J. s.n. D159630* (BRI, CANB, DNA, NSW); Fossil

Head, May 1993, *Perner, J. s.n.* (CANB, NSW); Fossil Head, May 1993, *Perner, J. s.n.* (NSW)

Description. *Leaves* 82–128 cm long, with 208–242 pinnae, rachis terminated by a spine. *Petiole* 16–29 cm long, 4–21% spinescent, base light orange-brown-grey velvety remainder glabrous or with scattered grey hairs, glabrescent. *Median* pinnae with abaxial surface with scattered grey hairs, glabrescent, margins slightly recurved, pinnae spaced at 2.0–3.9 mm along rachis. Not illustrated.

Distribution. *Cycas maconochiei* subsp. *viridis* is only known from Fossil Head (Fig. 16). The type cited in the Flora of Australia vol 48 (Hill 1998b) is different to that cited in the protolog of the original description (Hill, 1996).

Cycas orientis K.D. Hill

(Figs 11H–N, 17)

Cycas orientis K.D. Hill, *Telopea* 5: 696 (1994).

Type: 48.9 km E of Badalngarrmirri Creek, Arnhem Land, N.T., 26 August 1991, *K.D. Hill 3936* and *L. Stanberg*; holo: NSW *n.v.*; iso: CANB *n.v.*, DNA.

Other specimens examined. (selection only, 29 collections examined). Australia, Northern Territory: 76.3 km SW of Nhulunbuy on Central Arnhem Highway, 30 November 2002, *Dixon, D.J. 1070* and *Rochford, D.* (DNA); 19.3 km E of Gan Gan turnoff, 26 September 1991, *Hill, K.D. 3943* and *Stanberg, L.* (CANB, DNA, NSW); 31 km E of Lake Evella turnoff on Gove Road, 12 September 1993, *Hill, K.D. 4510* and *Perner, J.* (DNA, L, MO, NSW); 2 km S Lake Evella township, 5 December 1994, *Larcombe, D.R. 129* and *Panton, W.J.* (DNA); Arnhem Land, E foothills of Mitchell Ranges, 8 December 1994, *Larcombe, D.R. 134* and *Panton, W.J.* (DNA); near Wonga Creek, 66 km SSW of Nhulunbuy, 25 July 1996, *Liddle, D.T. 1655* (BRI, DNA, NSW); 40 km NE of BHP airstrip, Arnhem Land, 17 June 1972, *Maconochie, J.R. 1507* (DNA); Caledon Bay, 22 June 1972, *Maconochie, J.R. 1556* (BRI, CANB, DNA, K); Buckingham River, 8 miles from mouth, near Gove, 21 February 1973, *McKean, J.L. 977* (DNA).

Description. *Stems* to 4 m tall. *Leaves* 52–124 cm long, with 96–210 pinnae, flat or very slightly keeled in cross-section, rachis terminated by a spine. *Petiole* 19–52 cm long, unarmed or 6–86% spinescent, base orange-brown tomentose and extending up petiole, glabrescent. *Basal* pinnae not reducing to spines although the basal 2–4 pinnae may be shorter than the preceding pinnae, basal pinnae spaced at 3.5–9.8 mm along rachis. *Median* pinnae 78–162 mm long, 3.3–6.3 mm wide, abaxial surface glabrous or very occasionally with scattered grey-brown hairs, pinnae midrib to rachis angle 53°–79°, flat to keeled in cross-section, margins flat to slightly recurved, bases narrowed to 1.8–4 mm wide, deurrent for 1–4 mm, apex pungent, midrib depressed above, raised and prominent below, pinnae

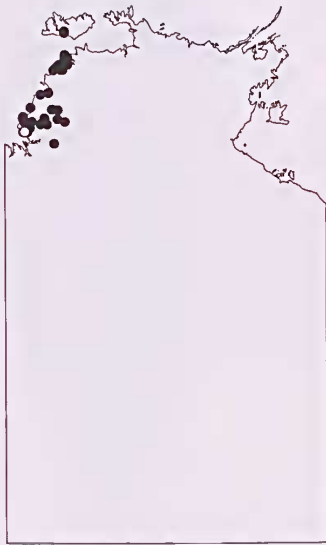


Fig. 16. Distribution of *Cycas maconochiei* in the Northern Territory. *Cycas maconochiei* subsp. *maconochiei* (closed circles), *Cycas maconochiei* subsp. *viridis* (open circle).

spaced at 1–4.3 mm along rachis. *Cataphylls* hard, pungent to 8 cm long, densely orange tomentose. *Pollen* cones ovoid, 13–20 cm long, 6–8 cm in diameter, lamina 20–21 mm long, 9–14 mm wide, apical spine 9.5–16 mm long, sharply upturned. *Megasporophylls* 21–24 cm long with 2–6 ovules, lamina 4–61 mm long, 10–25 mm wide, apical spine 14–41 mm long, margin dentate with 5–31 teeth to 1–2.4 mm long, orange tomentose. *Seeds* 30–37 mm long, 26–33 mm in diameter, slightly pruinose.

Distribution. *Cycas orientis* is endemic to the N.T., occurring east of the Mitchell Ranges in north-eastern Arnhem Land (Fig. 17). Occasional plants have been found growing within the range of *C. arnhemica*.

Notes. *Cycas orientis* can be distinguished from *C. arnhemica* by the flat to very slightly recurved pinnae margins.

Cycas pruinosa Maconochie

(Figs 18, 19A–I)

Cycas pruinosa Maconochie, *J. Adelaide Bot. Gard.* 1: 177 (1978).

Type: Ternon Gorge, Durack Ranges, W.A., June 1975, *D. Symon*; holo: DNA, iso: BRI *n.v.*, CANB *n.v.*, K *n.v.*, L photo seen, NSW *n.v.*, PERTH *n.v.*

Other specimens examined. (selection only, 30 collections examined). Australia, Northern Territory: Spirit Hills Conservation Area, c.17 km W of Bullo River Homestead, 18 August 1996, *Cowie, I.D.* 7125 (DNA, NSW); Spirit Hills Conservation Area, 22 October 2001, *Dixon, D.J.* 923 and *Kerrigan, R.A.* (DNA); Spirit Hills Conservation Area, 22 October 2001, *Dixon, D.J.* 924 and *Kerrigan, R.A.* (CANB, DNA); Kirkimbie Station, 7 August 1996, *Lang, M.* 6619 (DNA); Spirit Hills (Cycad

site 8, transect 3, plant 245), 10 October 1996, *Liddle, D.T.* 1710 (BRI, DNA); Spirit Hills Escarpment, 18 August 1996, *Michell, C.R.* 269 and *Cowie, I.D.* (DNA).

Description. *Stems* to 2 m tall. *Leaves* 72–110 cm long, with 158–420 pinnae, distal 2/3 strongly keeled in cross section, rachis terminated pinnae. *Petiole* 9–22 cm long, 7–58% spinescent, base orange woolly, orange tomentum extending up the petiole, glabrescent. *Basal pinnae* gradually reducing to spines, spaced at 3.4–9.8 mm along rachis. *Median pinnae* 124–168 mm long, 2.5–4 mm wide, abaxial surface orange-brown pubescent, glabrescent, pinnae midrib to rachis angle 51°–69°, flat to slightly keeled in cross section, margins revolute, bases narrowed to 1.9–3 mm, slightly decurrent for 0.5–2.5 mm, apex pungent, midrib slightly flush, or occasionally slightly raised above, raised and prominent below, pinnae spaced at 1.3–2.7 mm along rachis. *Cataphylls* soft, not pungent, velvety orange. *Microsporangiate* cones fusiform, 20–48 cm long, 5–13 cm in diameter, lamina 21–55 mm long, 10–17 mm wide, apical spine 6.3–10 mm long, sharply upturned. *Megasporophylls* 17–34 cm long with 1–7 ovules, lamina 64–122 mm long, 15–35 mm wide, apical spine 13–42 mm long, margin dentate with 22–53 teeth to 9 mm long, orange velvety. *Seeds* 30–35 mm long, 27–32 mm in diameter, pruinose.

Distribution. In the N.T., *C. pruinosa* occurs in the Spirit Hills area and on Kirkimbie Station of the Victoria River District (Fig. 18), and also W.A.

Notes. *Cycas pruinosa* is a very distinct species. The strongly pruinose seeds, size of the microsporangiate cone, and elongated sterile lamina of the megasporophylls allow for easy identification of this species.

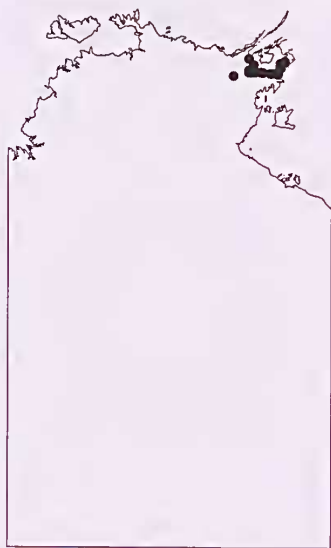


Fig. 17. Distribution of *Cycas orientis* in the Northern Territory.

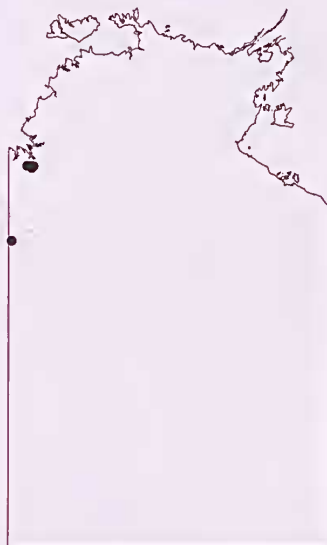


Fig. 18. Distribution of *Cycas pruinosa* in the Northern Territory.

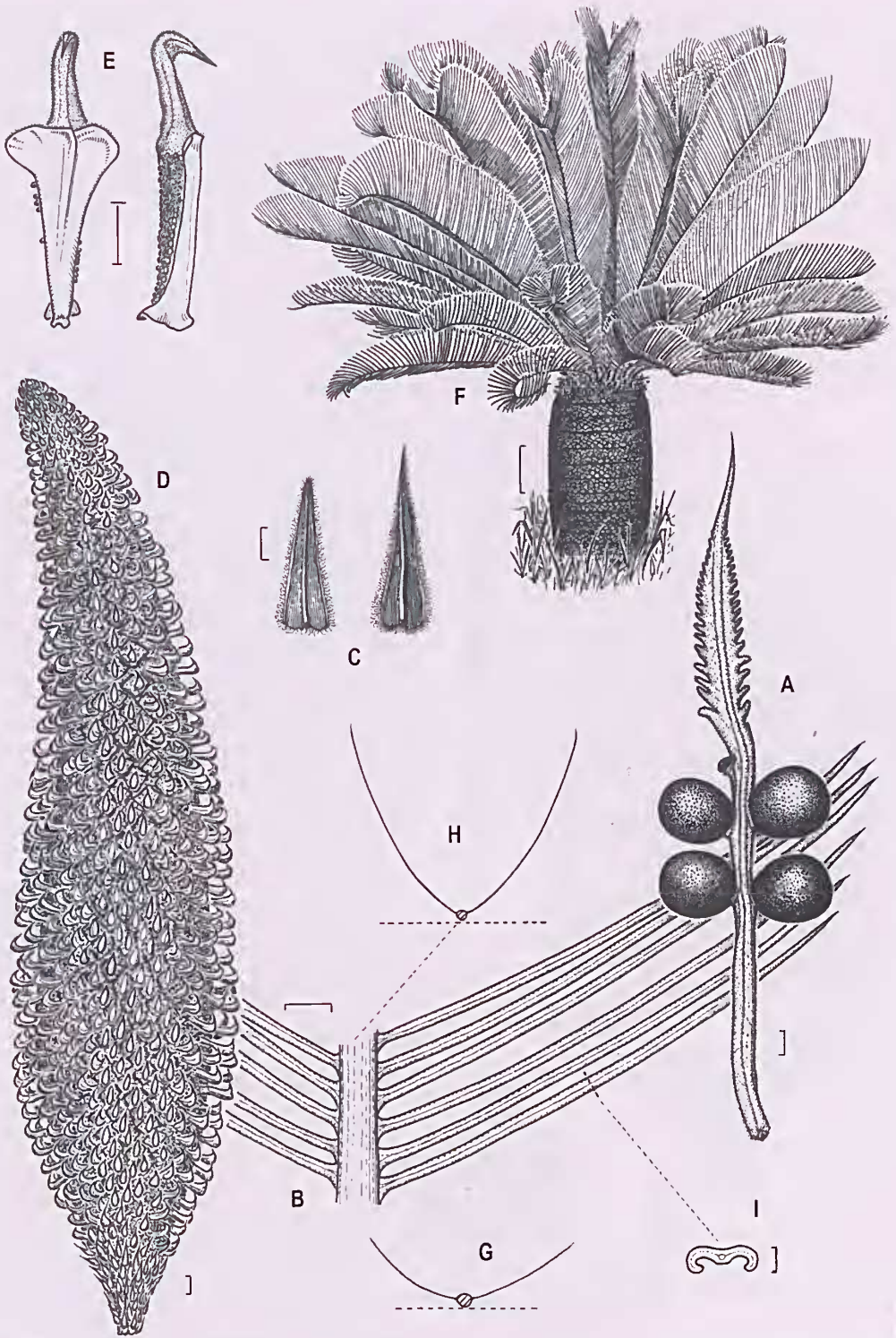


Fig. 19. A-I, *Cycas pruinosa*. A, megasporophyll (Liddle 1714); B, mid portion of leaf; C, cataphylls; D, pollen-cone; E, microsporophyll (Dixon 923); F, habit; G, C.S. of leaf base and H, distal part of leaf (GBDBG Living Collection 01-B000434); I, C.S. of pinna (Dixon 923). Scale bars: A-E = 1 cm; F = 10 cm; I = 1 mm.

Zamiaceae

A family of approximately 150 species representing seven genera. Found in Africa, North and South America, and Australia. Two genera, 40 species in Australia, with one species present in the Northern Territory. Taxonomic reference: Hill (1998b).

Macrozamia Miq.

Stem subterranean or erect. Leaves few to many, pinnate. Pinnae simple or divided, with parallel venation and no distinct midvein. Pinnae point of insertion to rachis often with a coloured gland. Male and female cones stalked; sporophylls with a terminal spine.

Macrozamia macdonnellii (F.Muell. ex Miq.) A. DC.

(Figs 20, 21A–E)

Macrozamia macdonnellii (F.Muell. ex Miq.) A. DC., *Prodr.* 16(2): 537 (1868); *Encephalartos macdonnellii* F.Muell. ex Miq., *Verslagen Meded. Afd. Natuurk. Kon. Akad. Wetensch.* 15: 376 (1863).

Type: Neales River, Macdonnell Range, N.T., J.M. Stuart; syn: MEL.

Specimens examined. (selection only, 20 collections examined). Australia, Northern Territory: c.0.5 km NW Hamilton Downs Youth Camp, 16 October 2001, *Albrecht, D.E. 10169* (NT); 9 km NNW Mt Lloyd, 16 October 2001. *Albrecht, D.E. 10171* (NT); Kings Canyon, below waterfall, 21 November 2000, *Barnetson, J.S. 40* (NT); Finke Gorge, 1 May 1996, *Dowe, J.L. 350* (DNA); Standley Chasm, 200 m N track start, 1 May 1995, *Hay, P. s.n.* (NT); 30 km

E Glen Helen Lodge, Chewings Range, 27 June 1991, *Latz, P.K. 12000* (DNA, NSW, NT); Mt Sonder, S face, 30 June 1991, *Latz, P.K. 12023* (DNA); 9 km NW of Ormiston Gorge, 1 June 1993, *Latz, P.K. 13209* (DNA); 5 km S of Harts Range Police Station, 27 October 1993, *Latz, P.K. 13446* (DNA); Mt Hay, 20 km W of Hamilton Downs Homestead, 16 August 1995, *Latz, P.K. 14477* (DNA); Palm Valley, 21 March 1953, *Perry, R.A. 3496* (CANB); Ruby Gorge Ranges, SE Ruby Gorge, 15 October 1989, *Soos, A. 131* (DNA).

Description. *Stems* to 3 m. *Leaves* 150–220 cm long, moderately keeled with 120–170 pinnae, dull blue in colour. *Petiole* 12–48 cm long. *Basal* pinnae reducing to spines. *Median* pinnae 18–30 cm long, 7–11 mm wide, margins flat, apex spinescent. *Pollen* cones fusiform to 50 cm long, to 11 cm in diameter; peduncle to 11 cm. *Microsporophyll* lamina 30–40 mm long, 15–31 mm wide, apical spine to 25 mm long. *Seed* cone ovoid 40–50 cm long, 20–27 cm in diameter; megasporophyll with an expanded, peltate apex 8–12.5 cm wide, 4–6 cm long; apical spine to 20 mm. *Seeds* ovoid, 50–80 mm long, 33–53 mm wide; sarcotesta orange to orange-brown.

Distribution. Endemic to the N.T. where it is restricted to the MacDonnell and adjacent ranges (Fig. 20).

Notes. Grows in rocky gorges of quartzite and granite. Trunks of larger individuals are sometimes reclining. Due to many specimens from DNA and NT being incomplete, the above description is modified from Hill (1998b).

Hill (1998b) in the type citation for *M. macdonnellii*, indicated that a syntype may be at MEL. In a personal communication from Kathy Sommerville, the collections manager at MEL, a Stuart specimen with location details matching the type citation was located at MEL. A colour photocopy is at DNA. No material matching the collection details for the Stuart specimen was located at L or U (Gerard Thijssse, pers. comm.).

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Fig. 20. Distribution of *Macrozamia macdonnellii* in the Northern Territory

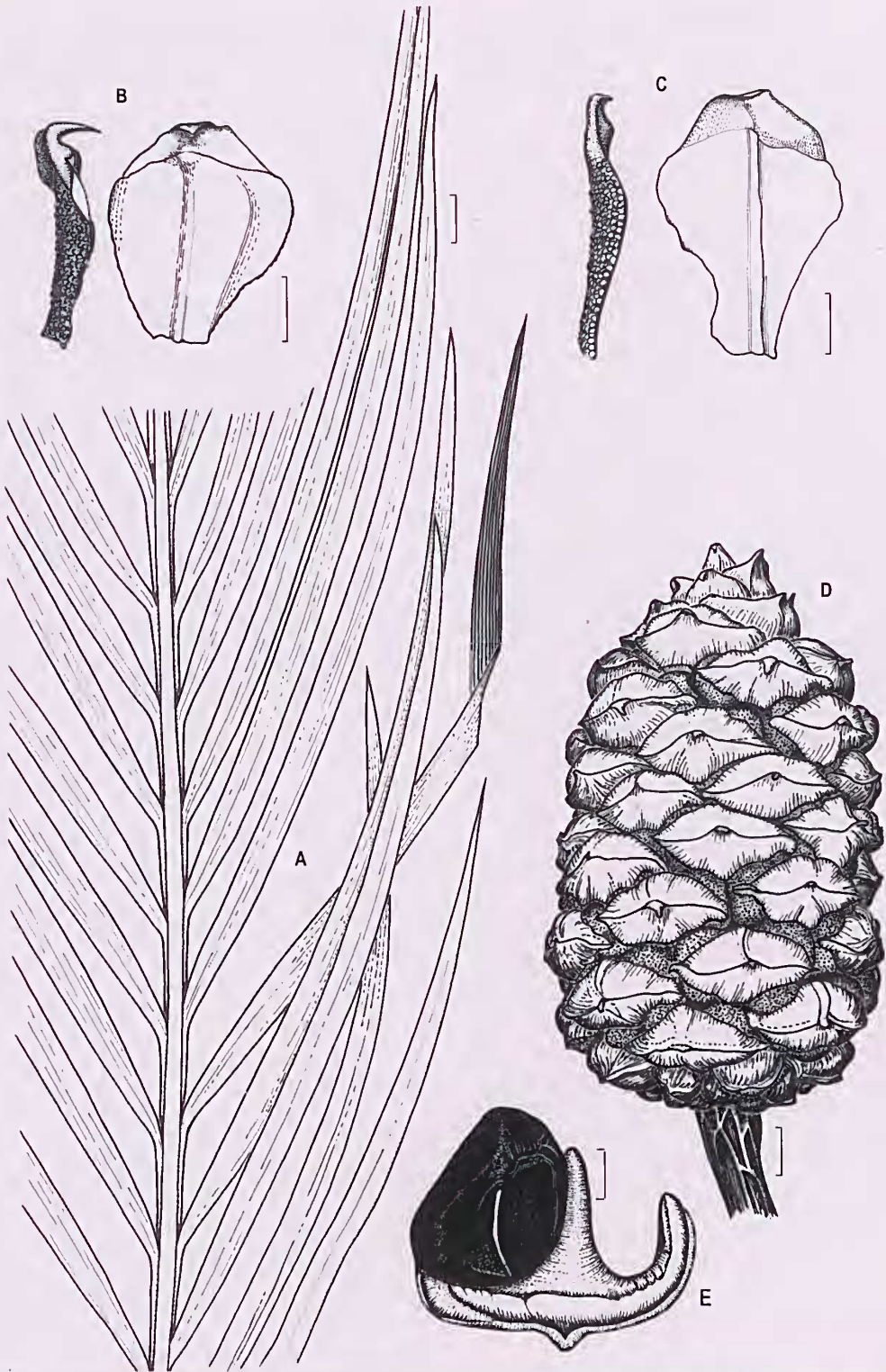


Fig. 21. A–E, *Macrozamia macdonnellii*. A, mid-portion of leaf (Soos A255); B–C, microsporophyll side and adaxial view (Latz 1131); B, from tip of male cone; C, from middle of male cone; D, female cone and E, megasporophyll with seed (Forde, s.n. DNA photograph collection). Scale bars: A–C = 1 cm; D = 4 cm; E = 2 cm.

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